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STEAM TURBINES.

PROF. BARR endeavours to balance the advantages or otherwise of steam turbines in a recent communication to *Cassier's Magazine*. He points out how very nearly the De Laval turbine was anticipated in Branca's steam engine in 1629. Indeed, Hero's reaction engine was not very far removed from the latest steam motor. The economy of the steam turbine, apart from its simplicity, is largely due to its freedom from what we term cylinder condensation. The metal of the steam turbine is practically at the temperature of the steam in contact with it at all times, and much loss is thus avoided that can only be minimised in the ordinary steam engine by careful attention to superheating. There are two forms of steam turbine—the Parsons and the Daw, and the De Laval.

In the two first, steam acts expansively upon one vane after another, until it creeps at a minimum pressure. This is the system of the guide blade turbines for water.

The De Laval turbine depends upon the impact of a jet of steam for its power. In this it is the comparison of the Pelton wheel, and is the better form, having no steam joints, if only there can be secured a peripheral or bucket speed in accordance with the velocity of flows of the steam itself. This is so enormous that we doubt if anything approaching the best speed has so far been secured. The De Laval is simply an impulse turbine, and as showing the present position of this simple engine, it is stated that two of 300 H.P. will soon be at work for the Edison Electric Illuminating Company of New York, to be built by the Maison Breguet of Paris. They will revolve at 13,000 turns per minute, and work with steam of 142 lbs. at the throttle, and will have condensers, and are guaranteed not to consume more than 18·7 lbs. of water per B.H.P., or 35·2 lbs. when non-condensing. If the turbines are to be built solely for condensing working, the consumption must not exceed 16·5 lbs., and the disc would be 29 inches diameter instead of 19⅝ inches as in the suggested mongrel type.

There are certain difficulties with the gearing and with the system of balance by means of the flexible yielding shaft, and in the Parson's type there is the difficulty of tight faces, but it is certain that with a De Laval turbine if a good result is once got it can hardly fall out, there being no parts to leak, and no serious chance of deformation of parts to cause less efficient action. It is curious how steam and water motors have both developed along the same lines in their latest forms. May we not hope to see something similar for the gas engine.

The Irrepressible Sturgeon.

IT is only a fortnight ago that we pointed out the misstatements committed by Mr. Sturgeon at the Tramways Institute on the subject of Mechanical Haulage on Tramways. Mr. Sturgeon is continuing his attempts to minimise the

advantages of electric traction in the Irish Press, and in a recent issue of the *Irish Times* endeavours to combat some statements of Mr. Barrington on the subject of overhead traction. The unfortunate part about Mr. Sturgeon's recalcitration is that he completely refuses to take cognisance of published facts as to the cost of working electric tramways. He says there are none, but Mr. Sturgeon lives at Leeds, and if he were to take trouble to enquire into the working of the Roundhay system he might receive some idea of what it costs. In Mr. Sturgeon's opinion, however, the only true comparison between electricity and cable is when they are working side by side in the same town, and under the same management. These conditions obtain only at Chicago where electricity costs 8·45d. per car mile and cable 4·97d.; consequently the whole question of electric traction must be considered in the light of Chicago experience. Of such are Mr. Sturgeon's arguments. He complains that as regards capital cost statistics are misleading because, in many cases, electricity can be applied to existing tramway systems, so that road construction has not appeared in the statement of cost, whereas the cable systems necessitated the entire reconstruction of the road. But is not that one of the paramount advantages of the overhead system; we had fondly thought so, but we apparently have lived in fancied security. Mr. Sturgeon, not satisfied with thus rudely dispelling one's fond illusions, proceeds to thrill the electrical world by "The fact that such a large proportion of the tramways in America are worked electrically does not, to those who understand American ways, indicate any superiority in that system. It is only an example of the mad rush on everything electric. There are many signs and tokens now of the beginning of the ending, and one of those signs is the effort that is being made to open up a new field in Europe for the almost played-out American systems." In the meantime, and notwithstanding Mr. Sturgeon, English towns are becoming rapidly converted to electric tramways, and, unless Mr. Sturgeon stumps the country, we are afraid his cause is a lost one.

The Treatment of Molasses by Electrolysis.

THOSE who are at all familiar with the cane sugar or beetroot sugar industry, are aware of the extreme difficulty which is experienced in extracting from the molasses, which, of course, are a by-product in the manufacture, all the crystallisable sugar. Various chemical processes have from time to time been devised with a view to recovering this sugar, but none of them can be considered as a complete success; there is still much to be done in eliminating profit-loss in this direction. Now that electrolysis has invaded so many of the departments of chemistry, and has attained so much success, it is not surprising that someone should attempt to solve the molasses problem by means of this kind of treatment. In the *Zeitschrift für Electro-Chemie*, 1896, page 573, there is an interesting paper upon the application of electrolysis to the treatment of the spent molasses obtained in the strontia and lime methods of manufacture. The author has investigated the question whether a substantial improvement in the quality of the crude potash obtained as a by product in sugar manufactories by the incineration of spent molasses may be effected by the electrolysis of such molasses prior to incineration. It will be seen that he is attempting to cut down profit-leakage, not so much by extracting more crystallisable sugar as by improving the quality of the by-product and thus enabling it to command a higher price. The experiments made in investigating this question were unfortunately on the small scale only, the amount of liquid being from 2 to 3 litres, whilst the electrical energy employed was only of 40 to 100 watts. The best results as regards current efficiency and increase in the proportion of potassium carbonate were obtained by operating on highly concentrated liquids, and without the use of a porous septum between the electrodes. By this means he succeeded in raising the percentage of potassium carbonate from 53·44 per cent. to 64·44 per cent. With weaker liquids the results were less satisfactory, probably because a portion of the current goes to waste in decomposing water. In any case the carbon anode is strongly attacked by the chlorine set free, whilst a non-conducting layer of lime and strontia, which must be frequently scraped off, is deposited on the cathode. From a monetary point of view the improvement effected appears to be balanced by the power consumed, electrodes, &c. On the other hand the process would offer decided advantages if the chlorine liberated by the current were found suitable for the production of bleaching powder. This point requires further investigation, and it is to be hoped that it will be carefully gone into before the idea of applying electrolysis to the treatment of spent molasses is abandoned.

Action of Electric Currents on Mine Surveying Instruments.

MANY of our readers will remember the experiments which were made shortly after the installation of the South London Electric Railway, which showed that delicate instruments situated at no inconsiderable distance from the railway were liable to be affected. In a town like London, of course, it is easy enough, if one wishes, to remove one's instruments from such influences—to do so, and still to find oneself conveniently situated in London. The subject, however, bears quite a different aspect in coal mines in which electric traction is employed. In the Westphalian coalfield electric railways are very rapidly upon the increase, and electric power is now used to a large extent. The question arose whether the electric currents exercise any detrimental action upon the magnetic mine-surveying instruments, which are used so largely in these mines. In order to determine this, W. Lenz undertook to investigate it, and his results were described recently in *Gluckauf*. He selected a point underground at a horizontal distance of about 100 yards from the rails of an electric railway, and 1,420 feet below it. There, by means of a Fennel's magnetometer with quartz fibre suspension, a series of observations of variation were made based on a fixed line. Observations were made both by day and by night. While the curve of the day results exhibited great irregularities, that of the night results was perfectly regular, and in accord with the magnetic records. The irregularities in quite small intervals of time amounted from 2·7 minutes to 5·4 minutes. As the observations were made at a comparatively large distance from other workings, and as the shaft was 200 yards away, it is evident that magnetic observations can, under such conditions, be only satisfactorily conducted during the night in the absence of the magnetic current. Another source of error is the safety lamp. Composed of various metals, the lamp in a hot condition sets up thermo-electric currents which act on the magnetic needle. In order to obtain information on this point, the author placed six mine surveyors' safety lamps free from iron, one at a time, first in a cold condition, then heated, at the pole of a sensitive magnetometer. Of the six lamps examined, two, when cold, had no action on the needle, whilst all acted on it when hot. The deviations observed amounted to from 30 seconds to 160 seconds. A new benzine lamp, that had not previously been used, caused a deviation of as much as five minutes. The deviation increased with the temperature of the lamp. A quite new aluminium safety lamp caused the same deviation when cold as when hot. From these results it follows that the mine surveyor, before making magnetic observations with delicate instruments, should carefully test his lamp. The influence of slight magnetic properties may be lessened by holding the light in the prolongation of the magnetic axis. With side lighting great care is necessary. It seems to us very important that every mining engineer and surveyor should be made acquainted with the results of these observations; otherwise, if they take their measurements during the daytime in the neighbourhood of electric plant, &c., their results are almost certain to be wrong, and trouble will ensue, for we take it that the mining engineer and surveyor are the most important functionaries connected with the coal mine. Finally, having in mind the recent researches of Dr. Fleming and Prof. Dewar on the influence of temperature on magnetism, it would be interesting to know what effect heat and cold, free from thermo-electric currents, would have upon the indications of the needle.

TRANSMISSION OF POWER IN MINES.

By RANKIN KENNEDY.

IV.

In non-fiery mines, the electrical cables, switches, and motors, may be of the ordinary kind, and run without any special precautions, ordinary 1,000 megohm rubber insulated cable carried on porcelain insulators from the generator to the shaft, and hung on insulators down the shaft, with a protecting board fixed in front all the way down. Sometimes a pipe is fixed, and the wires run through that in the shaft. If the pit is dry wood casing may be used below, but in non-fiery mines a good deal of liberty may be allowed in running wires, protection from personal contact with the conductors and from earth contacts being the only imperative requirements.

Motors will be required for haulage; where possible it is best always to drive from the motor to the haulage machine by belt, and a friction clutch used for stopping and starting. Whenever frequent stopping and starting is required, the friction clutch is preferable to electrical switches. Belt gear on high speed machinery is also much superior to spur or toothed gearing, although among mining engineers there seems to exist a prejudice against belt gear.

Worm gear is very satisfactory if well designed and well made, but the efficiency is low.

Motors for pumps present no difficulties, as pumping is generally a steady load over long periods, without stop. Motors for coal cutting machinery require very special designing. There are many different types of coal-cutting machines, and it seems as if it will take a long time to evolve the really successful machine to work with transmitted power. The side-wheel coal-cutter seems to have met with most success in this country. An ironclad form of motor is to be preferred, as it is proof against falls and rough usage, and whether toothed gear or worm gear is employed, the power should be transmitted through a clutch, so that the frequent stops and starts may be made without switching off and on current. There must, of course, be a switch for turning off and on current, but it should be used very seldom during a shift at coal cutting. The power required is from 7 to 15 horse-power, and as this power is expended at a slow rate, cutting into hard stuff, the strains and forces exerted on the machine are very great, hence side-wheel coal-cutters are necessarily heavy; that is their chief difficulty in narrow coal seams, and it is in narrow seams where coal cutting by machinery is most desirable. The author, after long experience, prefers a well designed bar cutter for small machines; it is easily handled, and no other design equals it in that respect.

Electric coal-cutting machinery, and for that matter, any coal-cutting machinery, makes slow progress; its chief advantage is not so much that it gets the coal a little cheaper per ton, but that it gets it without so much smashing and waste.

Drilling by electrical power is to a small extent practised. There are two methods; the boring or drilling by a rotary spiral drill or auger, and the percussion drill. The spiral rotary drill is used in coal and soft materials, and may consist of an ordinary drilling machine driven by an electromotor, coupled by a Stowe flexible shaft. About ½ to 1 horse-power is required.

The percussion drill has not been highly developed, the best forms are American in origin, but they do not seem suitable for many places, being heavy and inefficient. A good percussion drill worked by electricity has yet to be invented, but whether the demand for percussion drills driven by electricity is sufficiently great to repay an inventor is very doubtful.

So far, we have not considered the fiery mine: here we meet with problems in everything; the wires, the switches, and the motors are all of them required to be first and foremost free from the possibility of sparking, and the utmost care in laying the wires is required. Switches can be enclosed in gas-tight cases.

The motor for continuous currents is enclosed in a gas-tight case, which does not prevent sparking, but is designed to prevent the explosion of gas externally. Another plan is to enclose the brushes inside the commutator, and another is to generate chemically carbonic acid gas in a case surrounding the commutator, and thus prevent ignition.

But now that the commutatorless motor is perfected in the form of single-phase, two-phase, and three-phase induction motors, these somewhat lame devices are not likely to be perpetuated. The only motor for fiery mines is the induction motor.

They can be started with sufficient torque for all practical purposes, and are absolutely sparkless, and in reality much safer to handle than continuous current motors.

This last claim for induction motors is generally overlooked, but from the facilities offered in transforming the alternating currents used in induction motors we can work them at much lower electric pressures than the continuous motor, for in order to run the continuous motor with wires of any reasonably low cost we must use 300 to 700 volts right up to the motor. We cannot transform down to 100 or 50 volts, as we can with the induction motor.

Using the induction motor we can transmit a large power at very small loss through thin wires to a long distance, and then still be able to apply a low pressure to the motor.

In the non-fiery mine electrical transmission is cheaper in first cost and in maintainance, much easier applied, and higher in efficiency than compressed air. In the fiery mine it is much more efficient, and with induction motors quite as safe, although difference in first cost is not so great.

CONNECTING INCANDESCENCE LAMPS IN SERIES ON ALTERNATING CURRENTS.*

(*Concluded from page* 293.)

This diagram, which is sufficiently exact for the question under consideration, presents a great analogy with that in fig. 2. The analogy will be still greater, and will even arrive at identity, if we consider the modifications brought about by the extinctions of lamps. In short, the secondary current, i_1, becomes nil, and the whole of the primary, which is still supposed to be constant, is employed in magnetising the transformer, in which there is no secondary current to produce equilibrium. In consequence, the primary difference of potential, u_1, increases as before (to speak exactly, the C.E.M.F. increases, and with it u_1 as the component of the tension of the system required to overcome this C.E.M.F.), and the lag, ϕ, approximates to a quarter of a period; we find again, in consequence, the modifications represented in fig. 3. Here also the magnetising current will vary within wide limits, according as we introduce, for instance, a larger or smaller *entrefer* into the magnetic circuit of the transformer.

From the above, it is no longer necessary to show that for several lamps the relations remain the same as with the reaction coils. The two systems act in the same way both magnetically and electrically.

We have still, however, to indicate for both systems the mode of determining the necessary magnetising current for a given number of lamps to be extinguished simultaneously, when the variations of tension in the lamps remaining alight are not to exceed a fixed limit for a supply under a constant general difference of potential.

For this purpose let us study somewhat more closely some of the details of the diagram used in such a case. We see by fig. 3 that at every modification of i_m into I, there is a corresponding modification of u into u', as regards phase and magnitude. In the two triangles the vertical line is changed into the hypothenuse. The difference of potential, u', at the terminals (primary) of a transformer or a reaction coil after the extinction of a lamp, has always the same vertical component, u, and the fact remains for each lamp, even in the case where several are extinguished, as long as I remains constant, as has been supposed. For example, let two lamps be extinguished, as in fig. 6, the higher difference of potential, $2u'$, has a vertical component, $2u$, and a corresponding horizontal component. We see, then, that a lamp, whether burning or not, has always the same vertical component of the difference of potential (u), but that there

* By E. B. in *L'Industrie Electrique.*

is a certain horizontal component corresponding to every lamp extinguished. We can now simplify the diagram of a system of 4 lamps, two of which are extinguished, as shown in fig. 9; $U = 4u$ represents, as before, the total difference of potential of the system, when all the lamps are lighted, and

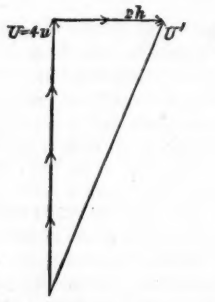


Fig. 9.

Fig. 10.

U' that which corresponds to the system with two lamps extinguished; $2h$ is the horizontal component belonging to the case of the extinction of 2 lamps. If, then, with the point O as centre (fig. 10), we describe with a radius $U = 4u$, an arc of a circle, we separate from U' a portion, ε, which, being equal to $U' - U$, gives the influence exerted by the extinction of two lamps upon the others; the difference of potential at the terminals of the lamps remaining alight increases, in fact, in the ratio $\frac{U'}{U} = \frac{U + \varepsilon}{U}$. If, for the sake of clearness, we reduce the whole diagram, so that U represents the total difference of potential, ε becomes the fall of potential throughout the system; for N lamps, the difference of potential at the terminals of these lamps increases by $\frac{\varepsilon}{N}$. In the majority of cases we can proceed by not reducing the diagram, and not taking into account the slight error resulting therefrom.

Hence the solution of the above problem becomes easy. Let us suppose that $U = Nu$ and ε are given, and also n, the number of lamps extinguished simultaneously, and let $N = 5$ and n 2 be taken as the numerical values, the values of u and ε being in any proportion whatever. We will draw vertically a straight line $U = 5u$ (fig. 11), and at right angles with it a horizontal line, H. Then we will take on the prolongation

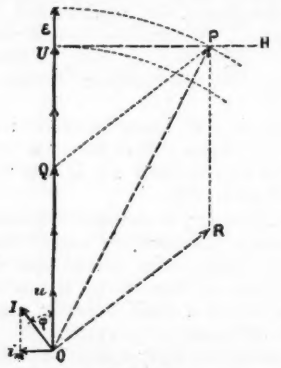


Fig. 11.

3 u, of the three lamps left alight; O, R, the tension; 2 u', corresponding to the two lamps extinguished. I is perpendicular to O R, and the horisontal component of I gives the required magnetising current, I_m; ϕ is the lag of the system. We shall thus easily determine in each particular case the necessary magnetising current and the lag belonging to it.

of U, the assumed fall of potential, ε (2 per cent. of U in reality, although the figure represents it as greater than this); with the point, O, as centre, and with the radius, $U + \varepsilon$, we will describe the arc of a circle cutting the horizontal line H at P, and join O, P. P, O will then be equal to the above magnitude, U', and we shall get $U P = 2h$ for the horizontal component corresponding to the two extinguished lamps. O, P $= U + \varepsilon$ being the magnitude required, by joining P and Q and completing the parallelogram, O, Q, P, R, we complete the construction. O, Q is then the difference of potential.

It may now be asked what is the degree of accuracy of the whole method. The approximation with which the current actuating without load the transformer or the reaction coil, is identified with the magnetising current as lagging by a quarter of a period behind the difference of potential, brings no appreciable error into the calculation; in fact, the loss by the heating of the copper of the reaction coil or the primary of the transformer, together with the loss by hysteresis in the iron, constitute only a small fraction of the total power (about 10 per cent.) so that the lag between the current for running without load, and the magnetising current is very small, and consequently the error resulting from it may be disregarded in practice. This error would have the effect of rendering the fall of potential, for a few lamps burnt, higher for the lamps in activity than their construction will bear.

Another and a much more important error results from the hypothesis, that the reluctance of the magnetic circuit remains constant. In consequence of the high saturation of the iron in the small transformers, or the reaction coils under consideration, when the induction that is necessary, from an economic point of view, attains to about 7,000 to 15,000 gauss, there can no longer be any question of an exact proportionality between the magnetising force and the intensity of the field; the difference of potential, u', will no longer vary with i_m, according to the ratio $\frac{I}{i_m}$; the diminution of the permeability of the iron will make u' increase more slowly, and with it the resulting total difference of potential, U'. With unfavourable hypotheses, all the ratios might even be reversed; in other words, U' might be lower than U, and consequently, for a few lamps destroyed, the others would burn with more brilliancy. This is not often the case, however, as the lag is generally about $\phi = 45°$, and consequently the ratio $\frac{I}{i_m}$ is virtually equal to 1·5; under these conditions, for a maximum induction in the iron equal, for instance, to 9,000 gauss, and it being granted that the magnetic circuit has generally a slight "*entrefer*" (for simplicity of installation), this circumstance could only be favourable in that the fall of potential would be less, and even *nil*, for the destruction of a single lamp. The curve of magnetisation of the iron used being known, it is moreover easy to see what takes place, and thus all error is avoided. In practice, an approximate estimate is generally sufficient to see whether the diminution of permeability does not by chance introduce an error of importance, for, for the whole system, it is not necessary to have the exact value of the fall of potential; practically it is sufficient to predetermine it approximately.

As regards the comparison of the two systems above described, we arrive at the following results:—

Given iron of equal quality, and copper of equal weight and value, the reaction coil system offers the advantage of a higher efficiency, in that we can use for the winding the whole of the space reserved for it. On the other hand, it presents this inconvenience, that we cannot, during the working, meddle with the lamps in immediate contact with the high tension. The result is, that we are obliged to insulate them very carefully, and we cannot place them indiscriminately; they must be placed as near as possible to the reaction coils, and kept away from houses and situations that are easily accessible.

The transformer system has, still for iron of the same quality, and equal conditions as to price, the inconvenience of a slightly lower efficiency, in that we only use half the space for each winding. This necessitates a greater density of current, which involves an increase of loss by Joule action. Moreover, the losses in the iron remain the same in both cases. On the other hand, the transformer system possesses the following important advantages over the reaction coil system: We can touch, or even replace, the lamps during the working of the system; they require less insulation with regard to the earth, and consequently can be fixed to houses, posts, &c., without fear of high tensions; lastly, the tension at the lamps is independent of that of the system and of the number of lamps. The employment of the transformer system is thus possible in all the existing alternating current

installations without employing lamps of abnormal tension. It was this consideration that led to the suppression of reaction coils in a little installation recently arranged by the Elektricität Actien Gesellschaft for the purpose of lighting by means of polyphased currents, under 2,000 volts three rather large streets with incandescence lamps. As the lamps were always to be lighted or extinguished from the station in groups of thirteen at once, their connection in series offered the simplest and at the same time the most economical solution of the problem. With reaction coils the lamps would have required at the terminals a difference of potential of $\frac{2,000}{13} = 154$ volts, which is neither usual nor practical. Recourse was had, therefore, to 78 little transformers of 88 watts each, connected 13 in series, and each feeding a lamp of 25 candles. The tension at the terminals of the primaries was 154 volts; that at the secondaries, 65 volts. The graphic construction thus gives for a primary current of ·58 ampere per lamp, a magnetising current of ·44 ampere, and, for the line current $\sqrt{·44^2 + ·58^2} = ·72$ ampere.

As these conditions correspond to a fall of potential of 2 per cent. when, out of the 13 lamps in series, two are extinguished, sufficient security is given. The position is even really rather better in consequence of the diminution in the permeability of the iron. The regulation of the necessary magnetising current is effected by the introduction at two points of the magnetic circuit of Bristol board ·3 mm. thick.

The trials, after installation, showed an excellent agreement between the calculated, and the actual results, the line current attaining effectively to ·75 ampere, instead of ·72 as calculated. The extinction of two lamps did not appreciably reduce the luminous intensity; four had to be extinguished before any noticeable effect in this respect was produced; but, when a fifth was placed on short circuit the rest regained their normal brilliancy. We are thus sufficiently guaranteed as regards the effect upon the other lamps against the extinction of any number of lamps, by putting some of the lamps in the independent groups out of the circuit or on short circuit.

The comparative simplicity of this graphic solution shows the services that can be rendered by this mode of procedure in the way of avoiding the complications and loss of time involved in the analytical method of calculation.

POWER FROM NIAGARA.

The first material step has at last been taken towards a transmission of the energy available at the Niagara Cataract Construction Company's works over considerable distances, and away from the immediate neighbourhood of the Falls. It consists of the utilisation of 1,000 H.P. in Buffalo for driving the electric tramways in that city, and the contract for erecting the overhead line for transmission purposes—let to the White-Crosby Company—is now being carried out. As our readers will doubtless remember, the great Niagara station, just equipped with Tesla-Westinghouse generators and horizontal Faesch-Piccard turbines, provides a 2,200-volt two-phase current; but in order to save outlay upon line conductors, a three-phase current is to be used for the transmission. At the Niagara end, the Construction Company is to put in three large transformers, from the General Electric Company's works; in the accounts so far to hand there are no details whatever given of these appliances, though their large size and novel use will undoubtedly invest them with great importance. They are to have a capacity each of 1,250 H.P., and will step-up the 2,200-volt two-phase current from the main Niagara generators to either 11,000 or 22,000-volt three-phase current.

In themselves, the transformers are designed for the latter voltage, but it is not proposed at first to work at more than half the full pressure. What arrangement is to be employed for changing the mode as well as the pressure of current does not yet appear; and we shall await further particulars with interest.

The pole line has a length of about 25 miles, and is intended to comprise four distinct circuits, having a total capacity equal to 40,000 H.P. at the higher pressure above-mentioned. We do not wonder at the statement that it is to run along a private right of way between Niagara and Tonawanda; to work at such voltages requires enormous care for the employés, not to speak of the public, and the line ought to be guarded and protected as carefully as human understanding can devise means to do so. Bare copper cables are to form the conductors, each stated to be of 350,000 circular mils section. About 2,000 poles are to be used, so that they will average 80 to the mile, or 65 feet apart; they will be of wood (white cedar) from 35 to 65 feet long, shaved and painted all over, and where necessary set in concrete. It would not be an excessive precaution to do this in every case, whatever the subsoil, for poles of this length require a very stiff foundation.

Three cross arms only are provided for each pole; the two upper ones are of 6 inches × 6 inches yellow pine, 12 feet long, recessed 2 inches into the pole, to which they are each fastened by two $\frac{5}{8}$th inch lag bolts, 7 inches long, and angle iron double bracket underneath. The third cross-arm is only a small one intended to carry a telephone circuit. How will it work? Each of the long arms carries three conductors on each side of the pole, so that there are four sets in all. The wires are guarded by uprights at the ends of the cross-arms, and a barbed wire is run along the top of these uprights on the upper arm, a similar wire being also run along the tops of the poles themselves. These are grounded every 500 feet or so as lightning protectors.

The insulators are of a special type, measuring $7\frac{1}{2}$ inches in diameter, and are triple-petticoated with a gutter on the outside to prevent formation of icicles between the bell and cross-arm.

At the Buffalo end, the re-transforming apparatus is set up in the street railway power-house; it includes four transformers, each of about 360 H.P., reducing the line pressure to one of 400 volts. Then the current is taken into rotary converters or alternating motor-generators, having three-phase collector rings at one end of the armature and a direct current commutator at the other. These machines are two in number, each of 500 H.P., and have six poles, running at 500 revolutions per minute, and feeding from the commutator direct into the trolley wires in the usual way, at 550 volts. We gather from the descriptions so far published that the rotary converters are of the double wound armature type, as indicated above, though they are also said to have compound-wound fields, and run in parallel with the ordinary steam-driven generators also at work in the same power-house. It will be highly interesting to have more details of these appliances, and still more so as time goes on, to see how they work in actual practice and economy.

REGULATING ELECTRICITY SUPPLY IN SOUTH AFRICA.

The Government at the Cape of Good Hope has issued a set of regulations for electric light and power undertakings and electric traction under the authority of their Electric Lighting and Power Act of 1895. Evidently the Board of Trade regulations and our model order have been taken as a basis, but the more stringent provisions have been relaxed or modified to suit local circumstances. The definitions of high and low pressure remain in the form we know them, but a higher pressure than 500 volts continuous may be allowed in electric traction by permission and subject to proper safeguards. Where the Board of Trade are referred to in our regulations, we find the words "Government" and "Governor" substituted, and the scope of the different rules has been extended to power conductors, and those used in connection with traction work. The word "adjacent" has been inserted before "terminals" in No. 1, so as to remove an ambiguity which might lead to the impression that not more than 250 volts may exist across any pair of terminals in a consumer's premises. From Nos. 2 to 12 the English wording is followed, but No. 13 is confined to aerial lines, so that it is apparently to be understood that no limit is set to the power to be transmitted through any *underground* line.

The consent of the Government is required to erect an aerial line at a less height than 20 feet or lower than 35 feet

at a street crossing, or nearer than 7 feet to a building. These figures are somewhat higher than those enforced by the Board of Trade, but trolley lines are specially exempted from this provision. The encasing of aerial service lines in rubber tube is not apparently considered necessary, as this part of our No. 20 is omitted. Nos. 28 and 30 do not appear, and in place of our No. 31, the following, which is worth quoting, is given. Compared with the Board of Trade restrictions, it is straightforward and sensible (although the title is a misnomer):—

"Conduits to be Kept Free from Gas.

"Where the conductors in any conduit are not continuously insulated, adequate precautions shall be taken to insure that no accumulation of water shall take place in any part sufficient to raise the level of the water into contact with the conductor."

The regulation dealing with street boxes is equally direct, but leaves it to the undertakers to adopt efficient means to prevent any electrical charging of boxes containing high pressure conductors, and does not make the use of what Mr. Hammond has dubbed the "octopus" compulsory. Nothing is said as to fuses or insulation of interior wiring or discontinuance of supply, and arc lamps are not even mentioned. The only regulation taken from our section B, dealing with supply, is No. 1, which requires 48 hours' notice to be given before commencing supply through any new main. The undertakers who have to conform to these new regulations are therefore left unfettered as to variations from a declared pressure, which apparently they are not called upon even to "declare," and no penalties for breach of the requirements are prescribed.

The regulations in regard to electric traction prescribe a non-pulsatory direct current dynamo as generator; an insulated line, and insulated or partially insulated return; frequent connection of the return conductor to the rails; uninsulated returns to be negative to line, and to have two auxiliary earth connections at the dynamo, placed not less than 20 yards apart, between which 4 volts must at all times produce a current of 2 amperes. Where an insulated or partially insulated return is used, it must be separated from the general mass of earth, and from pipes; the rails must be bonded; the difference of potential between parts of the return must be kept low, and the efficiency of the earth connections so maintained, that the current passing from the earth connections to the generator, shall not at any time exceed 2 amperes per mile of single tramway, or 5 per cent. of the total current output of the station, while the direction of current between any part of the uninsulated return and pipe in its vicinity must be capable of reversal by interposing three Leclanche cells in series, if the flow is from the return to the pipe, or one cell if the current flows from pipe to the return. If the drop in the return exceeds 5 volts, a continuous record is to be kept of its value, which must not exceed 7 volts. The leakage on insulated conductors is not to exceed $\frac{1}{100}$th of an ampere per mile of tramway, and the insulation of underground cables must not be less than 10 megohms per mile. Good contact is to be maintained in all parts of the circuit. Records of tests showing compliance with the foregoing regulations are to be kept.

Part 2 deals with the conditions to be observed by applicants for statutory powers to erect, maintain and work electric lighting and power undertakings. The terms are based upon our form of provisional order. Thus consent has to be obtained from local authorities, and copies of the draft Bill have to be deposited at the office of the Legislature at Cape Town. Maps have to be prepared, and other things done, in very much the same order as in England.

We come next to regulations as to breaking up streets for the construction of works. Public notice must be given, and plans furnished, before beginning such works, and reasonable precautions observed in carrying them out. Next follows sections affording protection to public telegraph and telephone lines. Then the duties of electric inspectors are given. The Government is entrusted with the appointment of such officers, and the duties are similar to those set out in English provisional orders. After setting forth how and in what manner "Notices" are to be given, the regulations conclude by giving power to the treasurer and the assistant treasurer to act on behalf of the Government, making the undertakers responsible for compensation in the event of accidents, &c., on their works, and requiring differences of opinion between the undertakers and owners of property to be settled by arbitration.

Although these regulations are not so far-reaching and stringent as those we have to work under at home, they appear to be well suited to the conditions of our English colony in South Africa, containing all vital provisions, and covering those points which, in the interests of public safety, must be the subject of legislative action.

ZINC IN BOILERS.

When surface condensers were first generally adopted for marine use, the gravest trouble was experienced from pitting in boilers. A British Royal Commission appointed to investigate the cause of the pitting, made one of the most exhaustive studies ever given to a subject of the kind, and in its report advised the employment of zinc in boilers to counteract galvanic action, and recommended that petroleum cylinder lubricants should alone be used, vegetable and animal oils being strongly condemned on account of the corrosive fatty acids formed under conditions similar to those existing in boilers. The two recommendations were at once adopted in marine practice, and trouble from boiler pitting almost entirely ceased. Unfortunately, two remedies being applied at once, their effects could not be differentiated, and though no difference of opinion now exists as to the necessity for the use of mineral cylinder lubricants, the zinc question has remained an open one for a quarter of a century.

For some years marine engineering opinion has inclined against the utility of zinc in boilers, and there appears, says the *American Electrician*, to be very good grounds for this view. The argument originally advanced in favour of the use of zinc was, that its presence made a galvanic cell of the boiler, and being electro-positive to iron, electrical action was concentrated on the zinc, the iron being thus protected. As, however, the electro-negative particles carried into the boiler from the material of the condenser were supposed to be deposited in small pellets where the pitting occurred, the action on this assumption was a local one, such as occurs in impure battery zincs, and this explanation fails. An additional theory, however, was advanced, according to which the entire surface of the iron of the boiler becomes, merely through the zinc contact, passive to electrolytic corrosive influences. One of the reasons offered in support of this theory was that the iron pot of a certain type of a voltaic cell is not attacked by the acid contained on account of being thus rendered passive, but subsequently it was shown that this was due to an iron oxide formed on the surface, which protected the metal. Apparently through a confusion of ideas, zinc also came to be considered as a scale preventive. Among the *a posteriori* arguments advanced in favour of this use was one asserting that electrical action deposits a thin layer of hydrogen on the iron, which prevents the adhesion of scale; and another based upon an assumed action of the electric currents generated and passing through the water, in keeping apart the scale-forming molecules and thus causing them to be deposited merely as a powder.

Whether any or all of the above theories are well founded happens to be a matter of indifference, for in practice the essential condition upon which they are based does not obtain. In order to have any electrical action whatever there must be metallic contact between the iron and zinc, and no such lasting contact can be maintained in a boiler, at least with the methods in vogue for securing the zinc. The contact surfaces may be ever so carefully cleaned, and the greatest of care taken to secure metallic contact when the zincs are originally suspended, yet in a very short time the zinc will be electrically insulated from the boiler by deposits between the contact surfaces. If, however, some method were devised to insure continuous electrical contact, the case would not be improved, owing to the very rapid consumption of the zinc that would ensue on account of the low resistance of the electrical circuit. Owing to the great area of iron surface opposed to the zinc, and the impurities (particularly if saline) in the water, the internal resistance of the iron-zinc voltaic cell would undoubtedly be small, thus producing a large current, which would rapidly consume the zinc, or, in some cases,

result in a layer of an insoluble zinc salt quickly forming on the surface that would serve to protect it from further electrical action.

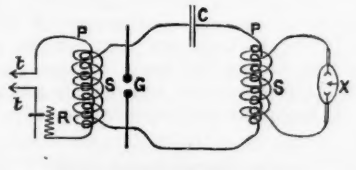
It has been noticed that in a few hours after placing zinc in a boiler using sea water, and in which steam had been raised in the meantime, the surface of slabs assumed a condition not different from what is usually noticed after months of immersion, thus pointing to a strong action when the contact and surface were clean—the final crumbling away of the material probably being due to chemical rather than to electrical action. The result of the use for many years of zinc in the boilers of naval vessels has been negative; in some cases where tests were made by suspending zincs in only part of the boilers of a vessel, no difference in scale formation or pitting was noted between the boilers containing zinc and those from which it was absent. As the arguments in favour of the use of zinc in boilers are little more than speculative, and since, besides, the conditions upon which they are based do not obtain in practice; in the lack therefore, of positive evidence of beneficial effects from the use of zinc, it would seem that an engineer is reasonably safe in assuming that he can neglect applying this so-called remedy for the evils to which a steam boiler is heir.

ON RONTGEN RAY APPARATUS OPERATED FROM ALTERNATING CURRENT CIRCUITS.

Messrs. Edwin J. Houston, Ph.D., and A. E. Kennelly, Sc.D., write in the *American Electrician* as follows:—

Röntgen ray tubes may be excited from any electric source of sufficiently high E.M.F., but the simplest apparatus, probably, consists of an induction coil excited directly by a battery of storage cells through a suitable interrupter. Excellent results are, however, obtainable from an alternating current incandescent lighting circuit as a source of energy, the recharging of storage cells being in this way obviated.

The connections suitable for the use of an alternating current incandescent electric lighting circuit are represented in the accompanying figure. *l*, *l* are the terminals connected to the alternating current mains of 50 volts pressure; R is a rheostat for regulating the current strength in the alternating current circuit; P is the primary winding, and S the secondary winding of a Ruhmkorff induction coil capable of giving an 8-inch spark. No interrupter is used. The secondary terminals are led to a spark gap, G, between brass balls. In the absence of any other connection, a current of about 10 amperes in the primary circuit will produce a continuous series of discharges between the balls



over a maximum sparking distance of 1 inch. If the spark be examined by waving a glass rod repeatedly to and fro in front of it, it will be found to consist of a series of discharges, each corresponding to one alternation in the primary alternating current from the incandescent lighting mains. The arc between the poles is quiet, flaring and of appreciable cross sectional area.

If the secondary terminals are connected with a condenser, C, formed of, say, three Leyden jars and the primary winding, P, of a Tesla induction coil, the spark at G becomes crackling, noisy, of dazzling whiteness and continuous in character. The stroboscopic examination of this spark with the waving glass rod shows that the discharges are more sharply defined and sudden in their character, apparently one to each alternation in the primary circuit

If a blast of air from a foot-bellows be directed through a glass nozzle between the brass balls of the spark gap, G, the sound of the arc becomes more rattling and its appearance rhythmically waving. The spark gap has now to be reduced to about 8 millimetres or about $\frac{1}{3}$rd inch. A stroboscopic examination of the spark with the glass rod shows that following each discharge at the alternating current wave in the primary circuit there is a rapid succession of equidistant discharges which may be 12 or more in number, and which may, perhaps, almost entirely bridge over the interval between successive main alternating current discharges. Thus, if the frequency of the alternating current from the mains be 15,000 alternations per minute, or 250 alternations per second, there will be 250 main discharges per second through the spark gap, and each such discharge may be followed by, say, 12 other discharges, each separated by, perhaps, $\frac{1}{20}$th of the interval between main discharges, representing a frequency of 5,000 alternations per second, and 3,000 sparks per second across the air gap. The frequency of these oscillatory discharges may be varied perceptibly by varying the number of Leyden jars in the circuit, and may be measured by attaching the glass rod to the shaft of a uniformly revolving motor and observing the angular distance between successive images.

The Tesla coil may be conveniently made by winding a coil of 80 turns of No. 18 A.W.G. cotton-covered wire in a single close layer upon the surface of a glass tube about 1 inch in diameter. The secondary is composed of about 320 turns of No. 30 A.W.G. silk-covered wire, also wound closely in a single layer upon the surface of a micanite tube 3 inches in diameter. The secondary terminals are led directly to the Röntgen ray tube, X.

The electrodes of this tube during the action of the apparatus are alternately the anode and cathode, while the anticathode is a platinum foil plate, bent into the form of a V. One discharge occurs in this tube at each spark across the spark gap, G.

The primary winding, P, of the Tesla induction coil is supported co-axially with the secondary winding, S, and both are immersed in insulating oil. This may be heavy paraffin oil, rosin oil, or kerosene oil, care being taken in the latter case that the oil is not readily inflammable. The sparking distance in air between the terminals of S is about 5 inches, and care has to be taken to prevent the apparatus from discharging through the insulating oil.

If the air blast be withdrawn, the fluorescence of the vacuum tube is fitful, and the illumination produced in the fluoroscope is variable. When, however, the air blast is steadily directed across the air gap, the fluorescence of the tube is vivid and the illumination in the fluoroscope brilliant and sustained. A good radiograph of the bones in the hand can be secured in about 30 seconds, and a radiograph through the body of a boy in about six minutes, as has been demonstrated in some experiments made in conjunction with Dr. William Pepper, of Philadelphia.

The Ruhmkorff induction coil used for this purpose need be no larger than is necessary to maintain a spark discharge of 4 mm. in air under the action of the blast. We have not been able to ascertain how small an induction coil is sufficient for this purpose, but we have reason to believe that it is considerably smaller than that which is necessary to furnish an 8-inch spark in air when excited from a voltaic battery through an interrupter.

The introduction of the Tesla coil appears to be necessary in order to obtain the requisite frequency of discharge. Without the condenser, C, the frequency would be limited to that of the alternating current circuit. The Tesla coil is excited with the frequency which depends only upon the reactance of the primary coil, P, and of the condenser, C. The spark discharges across the air gap, G, only serves to set the secondary system into oscillation, while the secondary coil, S, with the vacuum tube forms a tertiary system retaining the frequency of the secondary system. The capacity of the condenser has to be chosen by trial, such that the best fluorescence is obtained in the tube.

The only reason for making the diameter of the secondary winding, S, so large relatively to the diameter of the interior primary winding, P, is to assist in preventing discharges through the interior of the coil. A thick glass tube placed between the primary and secondary winding will assist in maintaining the insulation of the tertiary system. All the apparatus should be carefully insulated.

COMPRESSED AIR FOR TRAMWAY MOTORS.

THE correct use of compressed air is discussed by Mr. Rd. Parke in the *Western Electrician*. He admits the distrust that has been felt as regards this motive power, and endeavours to remove it. He states that in all cases air has been stored on cars at pressures considerably above what it has been admitted to the cylinders. Upon the amount stored depends the possible mileage, and the storage capacity can only be increased in two ways—either by actual enlargement of the reservoirs or by increased pressure. Obviously the first method soon finds a limit, and the temptation is to increase the pressure. But in doubling the pressure and therefore the power or mileage the cost is much more than doubled. Each cubic foot of stored air, at any absolute pressure of say p, has required an expenditure of power represented by W

$$= 144\, p \frac{s\, n}{n-1} \left\{ \left(\frac{p}{14{\cdot}7} \right) \left(\frac{n-1}{s\, n} - 1 \right) \right\} \text{ foot-pounds,}$$

where n is the customary number 1·408, or less where the air is cooled during compression. It is, of course, advantageous to compress in stages, and for pressures of 500 lbs. the number of stages should be three or four, and every effort should be made to cool between stages.

The following table will be useful, showing the power expended in compression and the restored work where there are four stages of compression :—

Gauge pressure of storage.	Work expended, w.		Work restored by motor.	Efficiency.
	Foot pounds.	Ratio.		
500	300,600	1·	1 000 w	1000 E
1,000	724,100	2·409	1·971 w	·818 E
1,500	1,201,300	3·997	2·943 w	·736 E
2,000	1,714,800	5·705	3·914 w	·686 E

Thus calling the efficiency at 500 pounds unity, that at 2,000 pounds is but little over two-thirds, and this shows the loss due to big pressures, a loss that can only be returned or, rather, minimised by some system of reheating, probably not readily carried out on a tramway. As a fact the actual efficiency is likely to be very much less than the tabular figures, for the leakage of a high pressure system must be greater.

In single stage compression the figures in the above table become as follows :—

500	...	461,500	...	1·535	...	1·000 w	... ·651 E
1,000	...	1,217,500	...	4·050	...	1·971 w	... ·487 E
1,500	...	2,134,000	...	7·099	...	2·943 w	... ·415 E
2,000	...	3,169,600	...	10·544	...	3·914 w	... ·371 E

This second table is clear proof of the absolute need for stage compression, and is directly at variance with the frequently made claim of so-called advocates of air that the increased cost of high pressures is insignificant in comparison with the increased mileage secured.

Compressed air cannot hope even in favourable circumstances to do much more than compete with the economy of the electric trolley system. To be successful air must only be stored at moderate pressures, and must be capable of being frequently recharged. Whatever can be urged collaterally in favour of air there is clearly a right and a wrong way of compressing it, and its advocates would do well to avoid claiming too much in its favour. Air is such an essential motive power in the proper place, and, indeed, so absolutely necessary, that it seems folly to push it into places where its chances of success are limited, to say the least.

SUPERHEATED STEAM.

PROF. THURSTON, who advocates superheating, stated his views in a recent paper before the American Society of Mechanical Engineers.

The recognised aims of superheating are the raising of the upper limit of temperature, whereby the factor, $T_1 - T_2$, is increased with improved thermo-dynamic efficiency. We venture to say that this item, which would be the only action but for the action of the cylinder metal, is really of small account, for after all, the value, T_1, is not really altered in most cases of superheating, for the superheat disappears in fulfilling item No. 2, which is stated to be the provision of heat to the cylinder, so as to prevent condensation of the initial steam. This, of course, constitutes practically all the benefit that we derive from superheating, being on all fours with item 3, which is stated to be the securing of a minimum discharge of steam to the condenser, and the minimum demand for water of condensation, both which are curious sequences of using hotter steam, as well as is also item 4, the reduction of back pressure, while item 5 is the increase of boiler efficiency on the basis of some otherwise waste heat now appearing as superheat. If the gain arising from superheat be computed on the basis of an adiabatic cylinder, it would be found trivial. Yet the gain is great in fact, and this fact alone should be enough to powerfully indicate to, if not convince, doubters that there must be an internal action of the cylinder walls that is prejudicial to economy, and which is to be checked by superheating. Examining some 50 results of experiments it is concluded that superheating will effect an economy of from 10 to 50 per cent., that a superheat of 100° F. will usually prevent all initial condensation and that even 15° or 20° will secure a valuable economy. It is evident that the large gains secured from moderate superheat may be due to the drying of previously very wet steam, and when the matter is thought out it is no matter of surprise that superheat secures an economy of from two to ten times the heat expended. For 52 observed cases, the gain due to 105° superheat was 26 per cent., while an economy of 20 per cent. followed upon a superheat of only 50°. The difficulties of superheating are those of lubrication and packing, both of which are less serious since metallic packing and high class mineral oil became common, or at least known. Then there is the difficulty with the superheater itself. It may form an obstruction in the boiler to the draught, and there is the further difficulty with its durability, and still again with the regulation of the superheat, which, says Prof. Thurston, needs to be varied with the size and type of engine, and with the degree of expansion in any one engine. Superheating will always give best results in the worst classes of engine, as may be reasonably expected, the simple engine, the slow speed engine, and the small engine reaping the highest benefit.

The following table gives the gain in ordinary cases :—

Engine.	Pressure.	Per cent. of condensation.	Ratio of heat lost by condensation and expended by superheating.	Amount of superheat.
Simple ...	50—100	50—30	5 to 1	100° F.
Compound	75—125	30—20	3 „ 1	75° F.
Triple ...	125—180	20—10	2 „ 1	50° F.

The best that superheating can effect would be to convert the steam engine into an ideal thermo-dynamic machine. It goes nearer doing so than any other known means, and the greatest problem for the steam engineer to-day is the working out of the problems of superheat in all its aspects of durability of apparatus and capacity for adjustment and regularity.

PYROMETRY: CALIBRATION OF THE LE CHATELIER THERMO-ELECTRIC PYROMETER.

IN a discussion of thermo-electric interpolation formulæ Silas W. Holman has shown* that the resultant thermal E.M.F. $\Sigma_o e$ of a closed metallic circuit of two metals, with one junction at 0° C., and the other at t° C., could be expressed to 0·5 per cent., or better, above 300° C. by an expression of the form $\Sigma_o^t e = m\, t^n$ or $\log \Sigma_o e = n \log t + \log m$, where m and n are constants depending on the metals of the couple. Similar demonstrations show that with the

Vide Proceedings of the American Academy of Science, Session 1885-96, p. 193; and ELECTRICAL REVIEW, 1896, No. 978, pp. 223-224.

cold junction constantly at 20° C., the E.M F. may be expressed by $\Sigma_{20}\, e = m\, t^n$ nearly enough. This fact, together with the known fact that the D'Arsonval galvanometer gives readings nearly proportional to the currents, and therefore to Σe on a circuit of constant resistance, led to the thought that the calibration of the Le Chatelier thermo-electric pyrometer might be simplified by the use of a logarithmic instead of a direct plot. A study of a series of six calibrations made at different times by four different sets of observers, with two distinct pyrometers, and, in nearly every case, with different suspension wires and adjustment, confirmed the deduction and led to the evolution of a new method, which requires calibration at only two known temperatures, instead of several, as formerly—a saving of labour and a gain in accuracy. The method is described by Holman in the Proceedings of the American Academy of Science, p. 234. Although it is suggested by the facts referred to, it is not merely a deduction from them. It should rather be regarded as an empirical process based on experiment. It is not rigidly exact, viewed from either a mathematical or experimental standpoint, but is merely an approximation holding within the limits of variable error of the instrument, and probably well within the limits of uncertainty of the assumed values of the melting points employed in calibration.

The Method.

Observations.—The scale is adjusted so that the spot reads zero with the circuit open. The cold junction is kept at a temperature about that of the room, and measured by a mercurial thermometer. The other junction is then exposed successively to two known temperatures, preferably boiling sulphur and melting copper, or, if temperatures upwards of 1,200° C. or 1,300° C. are chiefly to be measured, to melting copper and melting platinum. Deflections and temperatures of the cold junction are taken.

Correction for Cold Junction.—If the cold junction is always kept within about one degree of a constant temperature, t^0, *e.g.*, 20° (or 0°), both in calibration and subsequent work, these observed deflections require no correction. If that is not the case, then the deflection should be corrected to obtain what it would have been had this been done. This is really effected as follows: Let a be the change of deflection per degree at 20° C. This may be found nearly enough by observing once for all the deflection with the cold junction at some observed temperature, anywhere from 10° to 15°, and the hot junction at an observed temperature from 30° to 40°. The deflection divided by the temperature difference will, of course, be a. Then, if the observed temperature of the cold junction in a measurement is, *e.g.*, 16° instead of 20°, the correction would be $(20-16)\, a = 4\, a$, to be subtracted from the observed deflection, since that was obviously too large. These corrections are small, and can easily be made mentally, since a is seldom more than one-twentieth of a small division of the scale.

Calibration and Computation of Unknown Temperature.—Let d_s represent the corrected deflection for the sulphur temperature t_s (computed from the reduced barometric pressure H at the time by the foregoing formula), and let d_c be that for the assumed melting temperature t_c of copper or the metal used. Plot two points with log d as abscissa and log t as ordinate respectively. Draw through these two points a straight line. Then, within the limits of error of the apparatus, the ordinate of this line corresponding to any abscissa, log d will be log t, the log of the desired temperature of the hot junction, d being any observed deflection corrected to 20° or 0° as above. That is, the number corresponding to this logarithm will be t.

By far the most convenient way to effect this plotting and subsequent interpolation, instead of employing logarithm tables and the ordinary co-ordinate or plotting paper ruled with equidistant lines, is to use plotting paper with a logarithmic ruling, that is, with lines spaced at distances progressively diminishing according to the logarithmic law, like the divisions of the ordinary slide rule. By suitably numbering the axes of such a sheet, the desired quantities can be plotted directly without the aid of the logarithm tables. Subsequent interpolation then becomes exceedingly easy, since it is merely necessary to enter the plot with the corrected deflection as abscissa, and read off the corresponding ordinate on its numbered axis, this giving directly the unknown temperature, t.

The apparatus and procedure in calibrating is then divided at length, and illustrations of the apparatus employed are given.

Modifications of the Le Chatelier Thermo-Electric Pyrometer.—It is clear that the thermo-electric method is by far the most promising one as the basis for industrial pyrometers and as well as for much measurement in scientific research, and that the Le Chatelier form of the instrument is the most generally satisfactory one now obtainable on the market. Yet for general industrial services the Le Chatelier instrument falls short of the requirements in two ways. First, it is not sufficiently simple of manipulation in the setting-up, and in the calibration, to be put into the hands of any but a fairly well-trained observer. A trained chemist of works, an educated superintendent, or any man of such calibre may be expected to take the instrument as sent by the makers, mount it, and operate it successfully; and under such observers it is doing important service in many places. The mere reading can be done by any foreman after a few words of explanation. Secondly, the conditions of support requisite for the galvanometer, although often obtainable, are by no means commonly to be found in these portions of industrial works where it would be otherwise advantageous to locate the instrument. These facts are restricting the introduction of an instrument otherwise excellent in its performance, and marking a distinct onward step in the art of practical pyrometry.

The urgent need of a still more universally-practical pyrometer cannot be too strongly nor too often emphasised. In a large number of industrial processes of great magnitude the employment of a reliable pyrometer would certainly result in a notable advance in quality of product, in prevention of waste, in improvement or perfection of the process itself, and in the discovery of new methods and new products. If a galvanometer as reliable, as simple, and as portable as the Weston magnetic voltmeter could be directly connected to a rhodo-platinum thermal couple, there would result an almost ideal pyrometer for technical work. Thus far unfortunately, the Weston instruments do not yield in this combination sufficient sensitiveness to admit of their being put forward as meeting any but very special needs. However, a portable form of D'Arsonval galvanometer, combined with a rhodo-platinum thermo-couple, and graduated in degrees up to 1,500° C., has recently been announced by Keiser and Schmidt of Berlin. Its graduation is based upon the investigations of Holborn and Wien at the Reichanstalt.

THE AIMS OF TECHNICAL COLLEGES.

Prof. Riedler, the German engineering teacher, has been talking in a manner that ought to bring comfort to those who think that a white shirt course in a technical college is the one thing necessary to the salvation of British trade from the insidious attacks of the Teuton. The *Engineer* publishes an abstract from a recent address by the professor, which is commented on by our contemporary in a few words, of which the closing ones are: "Germany sees her error, but our scholastics clamour only for more subscriptions for more colleges and harmful scholarships, and enticements to underrate workshop hard work." We recently commented, ourselves, upon Prof. Thurston's very exaggerated remarks in regard to technical colleges, and the training they could give, and the demands of the American professor for their several million dollar colleges. The truth is, that while people demand more from technical schools than it is reasonable to expect, there will always be a full crop of trading professors to take advantage of their gullibility. Prof. Riedler says: "Knowledge, without practical application, is the cause of the growing disinclination of youth to do detail work, and at the same time of the increasing uselessness of those who have only scientific, *i.e.*, one-sided theoretical education. Another result is the decrease in self-education by independent work. The formal doing of the full amount of school work, and passing the necessary examinations, contributes its quota in keeping back youth from self-education."

D

The tendency is to the making of mere pedants and kid glove experimentalists, who seek for offices, attractive by reason of the social position they afford, and the freedom offered from the hurly-burly of practical everyday life. This class of training may be said, in fact, to fit a man only to get his living with a counter between himself and the general public. Now it is very largely of this stamp that German technical teaching has been, and the professor will have none of it. He would permeate the whole teaching with a more practical spirit, and thereby avoid the tendency of the German to be dreamy and dogmatical.

We do not know what the German youth is like at home, but we do know, from some slight experience, what a fearsome product the professor will become who has spent a few years teaching German youths. Dogmatic is no word for the overbearing arrogance, and the assumption of superior wisdom that is engendered. The highest scientific learning possible should only be offered to a select few students. Engineering must be taught, with a constant eye to practice, by men who can put in practice what they teach, and the sciences must be accorded less exclusive attention, though what is taught should be mastered. Engineering is by no means a necessarily mathematical science. It is necessary that there should be engineering mathematicians, but some of the best engineers we know are far from skilful in mathematics, and the science cannot be applied to the most difficult practical problems. Mathematics may go a long way to help one out in the economy of structural engineering when dealing with materials of known capacity, but it is of little help where conditions are abnormal and materials doubtful. Those who know Germany will appreciate the professor's remark, that the State and its officials exercise an unhealthful influence on the practical and economical sense, because all the higher studies are arranged specially for the training of State officials, and what can be worse than a German official? A certain amount of technical education is valuable, but we cannot overlook the fact that many German inroads upon English commerce have been made by reason of cleverly devised plans, as in the drug trade, and that where good work is done, English work of equal quality can compete. We may also point out that where English goods have lost in reputation, it has been through German firms. Who are the worst offenders in Manchester, for example, in respect of short lengths, misleading marking, and similar practices? We have reason to stick somewhat to the practice that has given English goods their reputation. Any loss of repute has been due to departure from the old system, not to any particular lack of the new knowledge.

A PROBLEM IN ELECTRO-DYNAMICS.

[COMMUNICATED.]

In the comments on this subject it was desired to point out that the fallacy in the proposition arose from the theory that cutting the lines of force by a conductor sets up E.M.F., and it was shown that the theory that E.M.F. is due to rate of change in flux density, was less liable to lead to fallacies than the cutting of lines of force theory.

Mr. Finlay, in his letter on the subject, admits the superiority of the flux density theory in discovering the fallacy in his own device, and his illustration, so far from supporting the arguments in favour of the cutting of lines theory, actually proves that theory untenable. The ring core is of iron, for he shows the lines distorted out of their path. Now, one may assume the ring to have considerable cross-section, in which case the wires on the inside of the ring will be shielded, and no lines of force will pass across the space inside the ring, so that the inner wires cannot be cut by the same number of lines as the outer wires; hence there should be, according to the cutting of lines theory, considerable E.M.F. It is quite easy to prove that whether the ring is at rest or moving little or no lines of force pass in the space inside, whereas, according to Mr. Finlay, the flux inside the ring should be as dense as outside. If the ring was made of wood, the arguments would hold good, but then the lines would not bend to follow the shape of the ring. In neither case can an E.M.F. be set up, for the flux density remains unchanged.

The case cited by Mr. Finlay of a conductor moving in a uniform field setting up E.M.F. is the only one in which there is any difficulty in applying the flux density theory; this solitary case only proves the statement that these theories are convenient fictions, both of them. It is to be feared that in these later days theories, which never were put forward as actual facts, have become accepted as such. The flux density theory is very convenient, and seldom leads to fallacies, whereas the cutting of lines of force theory leads many a one into false conclusions, and even to the useless expenditure of time and money. And this cutting of the lines of force theory requires to be bolstered up still further when we come to apply it to transformers and hole-wound dynamo armatures. Another fiction is required; we must assume the lines to form rings which expand and contract. This they certainly do not do, for in a hole-wound armature there is no torque whatever on the conductor, showing that no cutting of lines goes on. Are we to be asked to believe that the magnetic flux will leave the soft iron and snap across an air space of about 2,000 times the magnetic resistance?

Then take a ring form of transformer working at any load. We cannot discover more than a mere trace of magnetic forces in the inside of it; yet, according to the cutting of lines theory, we are to assume that the total flux flashes across the space inside of the ring; on the flux density theory we require no such absurd assumptions, the flux is confined to the iron only, except the little inevitable leakage. In a well-made ring transformer we find the force or flux remains in the iron ring, simply rising and falling and changing in direction, and that is sufficient, according to the flux density theory, to account for the E.M.F. in the secondary. But according to this contracting—and expanding—closed circuit—lines of force—cutting the wires theory, we are asked to assume what we can prove to be untrue.

Fig. 1.

Fig. 2.

Fig. 1 represents a ring transformer with its primary only, the lines inside the winding represent the magnetic flux at its maximum value in one direction, exactly as we find them by actual experiment.

Fig. 2 represents the same ring with the lines outside the winding, for to cut the wires, the lines must expand out and collapse again. Are we to believe that they leave the iron to cut the wires, even although we cannot discover any such lines or force outside the ring, nor in the space inside the ring?

The case of the cylindrical conductor in a uniform field is perhaps best explained in Mascart & Joubert's "Electricity and Magnetism," Vol. i, p. 434, without assuming the cutting of any lines of force.

It is not intended to prolong this discussion further than this; the author would impress upon writers, teachers, and lecturers, the importance of selecting that theory which best accords with known facts, at the same time making clear that it is only theory. One could show up some much used text-books on electrical engineering, wherein the cutting of lines of force alone is used to explain all electro-magnetic induction in a most pernicious way. If ever the students brought up on such pabulum become practically engaged in designing electro-magnetic machinery, they are destined to some rude awakenings. The fact is that until we find out what constitutes the magnetic field of force, we must use some working hypothesis; and the rapid advance in the practical applications of electricity and magnets in recent years has more and more compelled the abandonment of the cutting of lines theory of induction, and confirmed the theory that induction is due to change of flux density.

A favourite, but unreal, explanation of the induction of a current in a wire adjacent to another wire in which an alter-

nating current is passing, says that when the current starts it sends out circular lines of magnetic force in ripples like the rings rippling on the water when a stone is thrown in; these rings cut the other wire, and so set up an E.M.F. When the current stops, these rings collapse on the wire, and in doing so cut the wire, again setting up a wave of E.M.F. It is a very pretty fiction, but in all the science of magnetism and electricity there is not one iota of evidence to support the shadow of a proof that any such action occurs.

It is quite as easy, and much more rational, to explain the effect by showing that the one circuit encloses the whole, or part, of the magnetic field of force produced by the other, and that the variation in the amount enclosed sets up the electric induction. Such an explanation requires no wild assumptions to support it, such as expanding and collapsing tubes or rings.

MODEST REQUESTS.

There are two sets of conditions that give rise to discontent and grumbling amongst passengers and travellers generally on railways and tramways; the first of these, of course, involves the idea of antiquity and dilapidation, such as in this country can chiefly be found in our best beloved old fossil—the Chatham and Dover Railway (with the South-Eastern not far behind), and also on seven out of every 10 horse tramways. The second state is the opposite extreme of great comfort and consideration for passengers—and it would be invidious to specify in this instance; both of them, however, cause heartburning, either because passengers are badly treated and demand improvements, or are pampered and can find no limits to their expectations of progress. There is every justification for "kickers" in the first case—the more the better; but to rebel in the second instance shows base ingratitude.

Some of the American railway and tramway companies, however, have plenty of it to combat, though one would have thought their tramway services hardly capable of improvement from a passenger's point of view, now that so many of them are "electrified." We recently noticed in the *Railroad Gazette* an amusing skit on the "modest" demands of travellers, apparently upon a local line serving suburban traffic, and evidently composed by the management that has such demands to meet and satisfy if possible. Could the imagination ever paint progress in tramway conditions in this country sufficiently great to suppose something of the kind happening here in connection with a local or suburban service? The particulars are somewhat as follows—set forth in the manner of a petition:—

To the Management of the Broken Back and Wrecked End Railroad:

The undersigned residents of . . . . desire to impress upon the management of the Broken Back and Wrecked End Railroad Company the urgent necessity of improving its service, bad management being evident in all details: . . . .

What we Want.

Cars on one minute headway.
Speed of 60 miles an hour.
A stop put to reckless running.
Private cars for every passenger.
Free buffet, reclining chair, and sleeping cars, fitted with library, bath, barber shop, "stock tickers," and observation compartments.
Annual passes.
Stock and bonds of company divided *pro rata* among patrons.
Tracks laid to our doors mornings and evenings, and removed in the interim.
Gentlemanly employés.
Free homes on line of road, with taxes paid.
Electric light and heat in winter, and electric fans in summer.
Cars to wait for passengers coming across lots within the half-mile zone.
Fenders on both ends of all cars while running.
Cars not to make any noise after we go to bed.
Boy on mule ahead of every car while in motion to warn foot passengers and scorchers off the track.
Blue grass lawn and tropical plants along the right of way.
Boudoir cars for ladies.
Free telegraph messages.
Flagmen at all crossings.
Interlocking switches.
All our freight and express parcels carried free.
Smoking cars and free cigars on all trains.
Cars to come to a full stop at all streets, lanes, and private farm crossings.
Free fire, life, and accident policies.

All cars to leave all stations at the hour, ¼, ½, and ¾, in order that we need not bother ourselves to remember such odd times as 9.24, 9.36, &c.

These are a few of the more modest concessions that we demand, and if not granted we pledge ourselves to buy bicycles and boycott the road.

The petition is signed by residents along the line of the road in the settlements of Lonesomehurst, South Lonesomehurst, Kickerville, Cranktown, Van Hide Manor, Bath Tub Corners, Soft Maple, Hardscrabble and New Utopia, by business men of these villages and by large property owners of the suburbs, whose interests are jeopardised by the bad transportation facilities afforded by the road.

Truly "Man wants but little here below, Nor wants that little long."

PONTYPOOL ELECTRIC LIGHT STATION.

In last week's issue we published a very interesting description of a modern village lighting plant in Ohio. At the present moment the lighting by arc lamps is almost wholly devoted to the streets, although eventually it is intended to furnish current for incandescents on commercial circuits. The generating unit is a 135-kilowatt machine, so that as regards structure of station and capacity, it is not unlike Pontypool. There, however, the lighting is wholly confined to business premises, no help being forthcoming from street lamps, although with gas at 3s. 9d. per 1,000 cubic feet, there seems to exist a very good opening in this direction, especially with enclosed arcs burning 150 hours with one pair of carbons, such as are used in the Ohio village, as the maintenance of such lamps must be ridiculously low. However, whether this eventually comes about or not, we imagine that the present customers of the Pontypool Company might add some of these lamps to their installations with advantage.

The establishments of the leading drapers, the charming and eminently comfortable "Crown" Hotel, and other business places, might be made very much more attractive at night by outside lamps of this description, and at a very small increase in their quarterly accounts, for it is more than probable that the "unit" would be supplied for this purpose, if not, indeed, all round, at a reduced cost. Moreover, there is but little doubt that exterior illumination would have the effect of bringing many strangers into the town from outlying districts, and this would naturally mean increased business. But even as it is, the success of the Pontypool Electric Light Company is so phenomenal, that it is a marvel to us why other and larger towns in South Wales—say, for instance, Llanelly and Aberdare—have not *their* central stations erected and paying good dividends to shareholders, for with coal delivered at the station for about 5s. per ton, the electric light has a real chance against 14-candle gas at an average price of 3s. 9d. per 1,000.

There are about 56 customers in Pontypool, but there should be many others if they could only be made to see the advantages of the electric light, and the saving which would be effected in the long run. We say in the long run advisedly, for the advocates of gas can but rarely see an inch before their noses, and only consider the one factor of cost of light against light from the mere candle-power point of view. And what a blessing for that most important of all edifices now lighted by gas, the local post office! When we call to mind the inestimable benefits which Mr. Preece conferred upon the employés of the G.P.O., one would think that from the health point alone the Government would insist upon having electric light in every post office where current is obtainable, so the Pontypool Postmaster should look to it.

Waste in other systems of illumination must necessarily go on, for no one turns out a gas jet completely when leaving a shop during business hours, or a room until finally retiring for the night. The trouble of relighting is too much, especially if one is frequently passing from one part of a private or business house to another; therefore, much of the gas supplied is simply burnt at waste, and the same may be said of oil. With electric lamps, on the other hand, and carefully designed switching arrangements, the whole of the supply can be usefully consumed, and no waste whatever is involved. Then, again, in the matter of cleanliness, the great outlay, which is absolutely necessary with gas in regard to cleaning, painting, papering, whitewashing, &c., is

reduced to a minimum by using electricity, and the immeasurably greater immunity from danger by fire which is secured by its use is also a consideration which need not be insisted on.

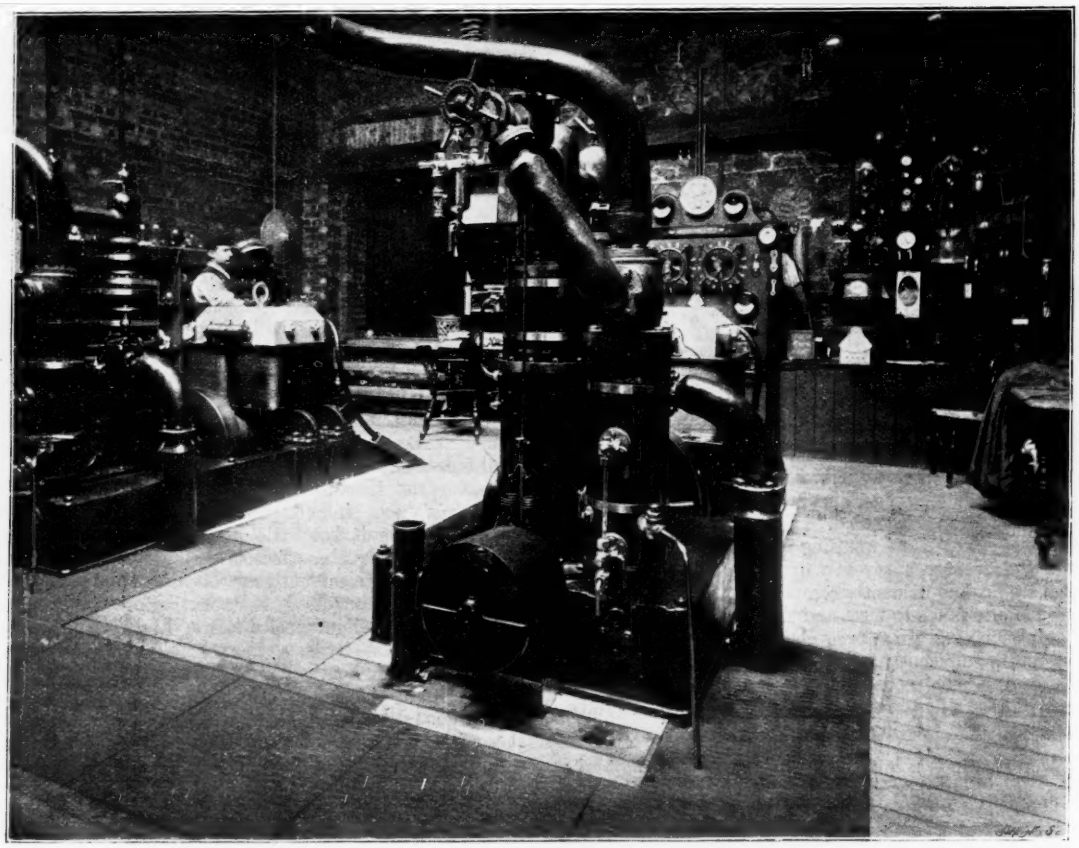
Such simple facts as these, and many others which might be adduced, already well known and fully appreciated by enterprising business people in large towns, have not been sufficiently brought before the notice of tradesmen and others resident in out-of-the-way country places where the gas element of the community has for years past been rampant, and where it is hard to persuade the residents to forsake the sins of their fathers, except by actual demonstration and trial of the light of lights.

The Pontypool central station, so well laid out and so admirably managed, was designed by Messrs. J. C. Howell, and still remains under their charge, Mr. Tiddeman, at periods of moderately large load. This is found to conduce greatly to economy.

The battery, the salvation of many central stations if engineers could but realise it, is of the Crompton-Howell type, and consists of 56 cells of 31 plates each. It has a capacity of 500 ampere-hours, the maximum charging current being 130 amperes. The mains are partly bare copper strip, strained up in culverts, and partly Callender's bitumen cable laid direct in the ground.

The system is two-wire, at 100 volts pressure. The number of lamps connected up to the present time is equivalent to 3,364 32-watt lamps.

The balance-sheet of the company we deal with in another place, and it says much, both from technical and commercial points of view, for the organising capacity of Messrs. Howell. We congratulate them heartily, and trust they



Pontypool Engine and Dynamo Room.

to whom we are indebted for some of our particulars, being the resident engineer. It is probably the smallest station—Chagford, perhaps, excepted —in the kingdom, and has been in actual operation about 2½ years.

The steam-raising plant consists of two Marshall's multitubular loco-type boilers, each of 20 nominal horse-power, the working pressure being 140 lbs. They are fitted with injectors and horizontal duplex Worthington feed pumps and Meldrum's patent forced draught furnaces.

The engine room contains two FF Willans compound engines of 60 indicated horse-power, and running at 470 revolutions. They are coupled direct to Crompton dynamos of the single horseshoe pattern. These are shunt wound, and are of 36 kilowatts capacity each.

Another Crompton-Willans steam dynamo is just being put down to meet the increased demand for current.

The switchboard, which was manufactured by Messrs. Crompton, contains an automatic cut-out for each dynamo, charge and discharge regulating switches, and the necessary meters. There is also a special switch for paralleling the regulating cells of the battery for purposes of charging

may induce the corporations of other South Wales towns to follow the admirable example of little Pontypool; for if electric lighting can succeed anywhere, it can surely do so over the borders.

CORRESPONDENCE.

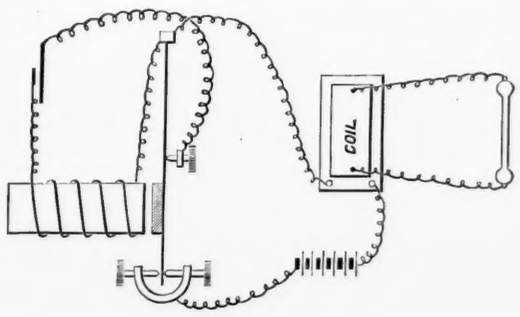
Making and Breaking Contact.

For some time past I have, in my leisure hours, been experimenting with the now well-known "haze" excited in vacuum tubes by electric oscillations on the lines of Hertz and Lenard, with the object, if possible, to work up this "haze" into a more useful light.

It is pretty evident, I think, that the amount of light emitted from these excited tubes, depends upon the rate (time) of the oscillations. Bearing this in mind, I set to work, attempting to increase their rate by "induction" means from the "secondary" of a coil, but without success. So I tried to attain my aim in an indirect manner, viz., by

increasing the number of "makes" and "breaks" in the primary, and I have accomplished this by the "break," of which I now forward a description to you, thinking it worth while so to do, as it might prove suggestive to those who have larger means at their disposal for the solution of this interesting problem. A rough sketch will explain the principle.

It will be noticed that it is an ordinary "break" (worked by a separate cell) with the addition of *two contacts* for the main circuit—battery and coil—so that at each complete swing of the hammer, "contact" and "break," occurs *twice*, whereas, under ordinary circumstances, of course, it occurs but once. The movement of the hammer being confined



somewhat by the two screws below, its swing is reduced and consequently still more quickened. By adjusting the several contact screws a very rapid "make" and "break" is effected, with the result that a considerable increase of power from the secondary is thus indirectly obtained. A vacuum tube influenced therefrom lights up in a decidedly improved manner.

Of course, the contacts below could be immersed in an insulating oil, but I do not find the result is improved, and, moreover, the oil soon carbonises at the contact, which introduces complications.

Alf. Jno. Paine.

Dynamo Patents.

I notice that at the International Congress of Electricians, Geneva, Herr Rothert has introduced the double circuit dynamo-electric machine for working the three-wire system from one dynamo, each pole to prevent sparking being divided into two parts. He made the positive statement that this machine was invented by Herr Dettmar; in that, however, he is mistaken. The invention of this machine was patented by myself on April 4th, 1882, No. 1,640.

The late Mr. Kingdon patented the same thing a few years ago, and so did some others. Mr. Kingdon, a few weeks before his untimely death wrote me expressing his surprise at discovering my early patent anticipating his own.

As the statement is made in your report of the proceedings I shall feel obliged if you will publish my correction.

Rankin Kennedy.

Electrolysis.

I have waited to see whether some one of your frequent correspondents would address to you an invocation to the Shade of Faraday (*vide* ELECTRICAL REVIEW, pp. 348, 349, and 385, Vol. 36), to labour with you about the error (?) you have committed on page 278 of the issue of August 28th, last.

The "Electrolysis of Tellurium" differs not in etymology from the "Electrolysis of Gold," which so horrified at least two of your correspondents in the month of March, 1895.

Is it that the term is coming to be used in the broad sense, which its construction allows and implies, in place of the limited sense only, of decomposition by means of electricity, so conservatively adhered to?

Verbum sat sapienti.

N. S. Keith.

September 8th, 1896.

INSTALLATIONS WITH INCANDESCENCE LAMPS AT HIGH VOLTAGE.*

THE adaptation of the incandescence lamp at a high voltage as rendered practicable by the improvements in the manufacture, is the problem which now chiefly claims the attention of electricians concerned with installations for lighting.

This problem may be thus formulated: is it preferable to use lamps of 100 volts with an efficiency of 2½ watts per candle-power, or lamps which absorb 4 watts with a tension of 220 volts?

Such an augmentation of voltage of the lamp renders it possible with leads of a given capacity to feed a double number of lamps with the same expenditure of energy. By redoubling the voltage it is permissible to reduce the section of the conductors to one-fourth with the same loss and under equal conditions.

Consequently, the dimensions of the conductors of a central station feeding with a tension of 220 volts, lamps of 16 candles absorbing from 64 to 70 watts, will be scarcely the half of that which will be required if the lamps were of 110 volts and consumed 2½ watts for candle, since the intensity of the current will be approximately the same in both cases.

If it is considered that the relative cost of the copper conductor constitutes one of the most important burdens of an installation, it will be understood, as experiment shows the advantage of a high voltage lamp.

Let us look at the practical consequences of the application of lamps of 220 volts in the distribution, and point out the advantages.

Let us suppose that in a supply-network the substitution of lamps of 220 volts for those of 100 volts has been completed. The voltage being double we may place the conductors at a double distance, yet maintain the same intensity of current with the same percentage of loss. But with a higher voltage, the same intensity of current in a conductor of given dimensions will furnish a greater energy, it will be permissible to double the number of the lamps.

Then, without increasing the section of the conductors, we may obtain a four-fold illumination, or again produce the same light carried to a quadruple distance with the same percentage of loss. Here is another advantage that the radius of the distributing network, being increased to four times the distance from the central station, the surface, which it is possible to serve with a single distributing station, becomes 16 times larger.

It is generally admitted that in a three-wire distribution system at 110 volts it is not economical to extend beyond a radius of about 1,200 metres from the works, except under special circumstances.

The corresponding surface is about five square kilometres. Admitting that in the centres of great cities there are contained about 12,000 inhabitants per square kilometre, a three-wire system at 110 volts will furnish economically current for 60,000 to 70,000 inhabitants of the central parts of great cities, and, in the suburbs, for 32,000.

On this basis it is easy to calculate the number of central stations necessary for the illumination of a great city. Theoretically, the use of lamps of 220 volts permits of the extension of the main supply leads to a distance four times that of the installations at 110 volts, whence there results an illuminated surface 16 times larger. But in practice it will be prudent to carry the leads only to a triple distance.

If the radius of supply is of 1,200 metres with lamps of 110 volts, we may calculate 4,000 metres for lamps at 220 volts illuminating 62 square kilometres of surface and serving 700,000 subscribers in the central districts (in place of merely 60,000, and rather more than 250,000 in the outlying districts). The history of the development of central stations teaches us that after two or three years' use the distribution network becomes overburdened, to the extent of rendering it necessary to enlarge it or to feed it with larger main conductors. The extension of such a system constitutes a very heavy outlay.

The lamps of 110 volts absorbing 2½ watts per candle have the advantage of offering an economy in consumption over that at 220 volts requiring 3½ watts per candle. This point will not be contradicted, but on the other hand the latter (lamps at 220 volts) have a longer duration, and the majority of subscribers prefer to recur to them to avoid the nuisance of frequently changing the worn-out lamps. Furthermore, we may expect to see lamps produced of 220 volts at 2½ watts. Here is a marked advantage which tells in favour of the adoption of high voltage lamps.

The good action of the lamp at 110 volts is remarkably influenced by the fluctuations produced during use, and which have the result of considerably affecting the duration of the lamp.

The insertion and removal of motors or lamps into, or from the circuit, causes variations in pre-existing lamps.

Suppose a subscriber situate at the extremity of a rather long circuit, who has a motor of 40 amperes, 100 volts. When he inserts or removes his motor from the circuit he occasions a fluctuation of the light in the adjoining lamps represented by perhaps 4 volts, that is to say, 4 per cent. of voltage in case of lamps at 100 volts, but if it is of 200 volts the current is readjusted to 20 amperes, but the corresponding variation of potential will not be of 2 per cent., but of 1 per cent. of the normal potential. The effect on the remaining lamps will be reduced to the fourth of the original value, and for the greater part of the time will pass unobserved. The apparatus will gain in steadiness and the lamps in duration.

The use of lamps of 220 volts with a three-wire distribution will cause the two outside wires to have a tension of 440 volts, which will be very suitable for feeding tramway motors. Such rational applications will procure for the works the means of obtaining a better specific utilisation of their material.

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* *L'Elettrica Rivista Settimanale.*

Summing up the advantages resulting from the substitution of lamps at 220 volts for those at 110, we determine as follows:—

1. The existing conductors will be able to serve twice as many consumers, giving room for a reduction in the percentage of loss.

2. The variations and fluctuations of potential due to the insertion or exclusion of motors, or of important groups of lamps, or to errors in working the dynamo, and those in the central station will be in the same manner reduced to a half.

3. We can serve new subscribers at greater distances from the works.

No system is exempt from certain objections, and which of them has the capital defect of not permitting us to use, or to extinguish separately, arc lamps used in private illumination.

In the actual state of things, with the distribution at 110 volts, it is sufficiently troublesome for the client who possesses only one lamp to pay for current the same sum as his neighbour who has two at his disposal. To absorb the excess of the unnecessary current with an inert resistance is an unsatisfactory solution.

On the other hand, public lighting will derive advantage by the arrangement of eight lamps in series between the two extreme wires of the distribution, governed solely by a single commutator.

The addition of the electric motors will not produce any inconvenience; their arrangement will be equally convenient for working at 220 volts and at 110.

As for the dangers of fire, a circuit at 220 volts, judiciously planned and executed, is exposed to less risk than one at a low voltage, because the fusible wires are lighter.

THE LAUNDRY EXHIBITION.

At the Laundry, Sanitary and Engineering Exhibition, which closed last Saturday at the Agricultural Hall, Islington, there were several exhibits of interest to electrical men.

The "electric boat," with its penny trip on the "ornamental pond" (the pond, by the way, was 6 feet in width), was the greatest attraction to one class of visitors. These trippers derived considerable pleasure from the bumping of the boat, first against one side, and then the other. Ornamentation consisted of a few evergreens, palms, &c., distributed scantily upon the whitewashed wall. Other visitors were interested in the performance of an electrical phæton to hold four persons, which was shown by the Great Horseless Carriage Company. This was the only autocar that was running on the occasion of our visit. We were warned of its approach by the trembling of the gallery of the Hall, and by a buzzing sound, something like the noise made by alternators sometimes heard at this office by telephone, or the gurgling of a phonograph. Our imagination carried us into the dim future. We thought of Cheapside or Fleet Street crowded with a few hundred vehicles of this kind, each giving forth a similar strain of weird sounds, and we stood rooted to the spot until the Pompadour Band struck up and charmed away our fears. In spite of the noise, however, the vehicle seemed to run very easily, and turned corners very exactly. It was well under control.

The floor of the Hall was occupied partly with a great array of soft soap, starch and curling tongs; but the more important exhibits were in the engineering and machinery line, and in this connection one cannot help noticing how extensively machinery is now employed in laundry work. Electrical heating apparatus was, of course, shown.

An important exhibit, from our point of view, was that of Messrs. Thomas Broadbent & Sons, Limited, of Huddersfield and London. This company showed running a steam driven hydro-extractor, and by its side an electrically driven one. The vibration caused by the steam extractor while running was considerable, whereas that caused by the electrical was practically nil. The motor is supplied with current from a Crompton dynamo driven by a Tangye gas engine. The electromotor forms part of the centre spindle carrying cage, and complicated mechanism is thereby obviated. The machine can be made to work in conjunction with any existing electric installation, and is provided with starting switch and resistance of special design, by means of which it can be started slowly, and the speed gradually increased until the maximum velocity is attained; or it may be run at any intermediate speed, as desired. The machine can be placed on any good ordinary floor without fear of causing vibration.

The Blackman Ventilating Company, Limited, showed, among their various exhibits, their electric fan and motor combined, which is a very neat thing, and would not mar the decoration of any building. We understand they are largely used at the Earl's Court Exhibition and other places, and as many as 50 are in use at the Hotel Cecil in London.

Messrs. R. & J. Dick exhibited their patent driving belts, and Messrs. Harbord & Poole also had machine bands and belts on exhibition. The gallery was largely taken up by the various stalls of Messrs. New & Mayne, who showed electric light, heating, cooking, and decorative fittings in great variety, also ventilating fans and other apparatus. Pearson's Automatic Fire Indicator Company showed fire and other alarms. The most tastefully arranged stand in the gallery was that of Messrs. F. A. Glover and Co., who showed how effectively the electric light may be used for purposes of illumination and decoration. They had a number of electric lamps, brackets, electroliers, &c., with glass and other shades of various colours, neatly arranged with grass, ferns, and other natural green. Electric bells and numerous electrical accessories were shown by this firm, which also supplied the plant necessary for the lighting of the Hall itself. Several firms exhibited water softening apparatus. Messrs. Babcock & Wilcox exhibited a model of their water-tube boilers; but speaking of these, we have seen a glass tube model elsewhere, under some 25 to 30 lbs. pressure, to illustrate the extraordinary effect known as water circulation, and which throws quite a new light upon the hitherto assumed action of such boilers; Messrs. Bagshawe Brothers showed pulleys, &c.; Mr. E. S. Hindley had on view engines, &c. Other stands were occupied by Messrs. Croggon & Co., Messrs. Doulton & Co., and Messrs. Easton, Anderson & Goolden, Limited.

A second horseless carriage to hold four persons—an electrical phaeton with thick rubber tyres—exhibited by the British Motor Company, Limited, seemed to be the only other vehicle included in the Horseless Carriage Show.

On the whole, the Exhibition was a very interesting one, and we believe the most extensive of its kind yet held at the Agricultural Hall. The power, electrical and otherwise, used in running the machinery amounted, we understand, to over 500 H.P., which is more than ever used at the Hall at one time before. Messrs. Cordingly & Co., the proprietors of the *Laundry News* and *Industries and Iron*, were the promoters of the show.

REGULATING TRAMWAY TRAFFIC FROM A CENTRE.

It is rather curious to find the "train dispatcher" entering upon the street railway field, now that absolute block signals are gradually abolishing his office on the chief American railroads. In the last number of the *Street Railway Review* there is a long account of the method adopted at Los Angeles (similar to others already in use at Denver and Portland, Oregon) for working the street tramways from a central office or station by means of telephonic orders addressed to the conductors of each car as they report their arrival under normal conditions at the route termini, and under special circumstances at intermediate points, where call-boxes are put up along the route for use in case of accident or breakdown.

The system of train despatching, by means of telegraphic orders, has undoubtedly done good service in time past on main line railroads where traffic is sparse, but it has admittedly serious limitations, not the least of which is the danger arising from excessive concentration of traffic under command of one human being, just as liable to error as another. Even in railroad service, however, it does not abolish altogether the time card or regular sequence of trains, but merely regulates and governs the traffic based on a previously arranged plan, well known to all the officials. As now proposed for the service of tramways in large districts, the method advocated in the *Street Railway Review* seems to go altogether too far, in leaving the entire arrangement of car service to the dispatcher for settlement and variation in the way that shall seem best to him at the moment, and having no fixed plan or time card whatever beyond a rough idea of so many minutes' headway between cars at different times of the day on different routes. Perhaps nothing could well show more clearly the facilities available in the States for street travel than this assumption of cars being always in sight, and of a three or four minute headway being the normal amount throughout; one object of the dispatcher method is, of course, to utilise out of so many cars every one to the utmost, by preventing a breakdown from interfering too much with the service, lengthening the headway in front of the block, so as to give time for its removal without long cessation of traffic.

Ideas of this kind are very ingenious, but rather complicated to work out in practice; still, for the prevention of stoppages and the provision of more cars for "rush" traffic, they undoubtedly are worth the trouble and expense of a complete telephone system over the network of lines to head-quarters. We certainly, however, would say that the time-card ought to be retained, and operated by under normal conditions, for the possible saving of a few minutes here and there will hardly be worth the risk of confiding the entire service to one man, and taking a good deal of responsibility from the conductors. For breakdowns and sudden demands for more cars, it is, however, most essential that telephone communication should be had at once with head-quarters, and every well planned system of electric tramways will have its telephone circuits not only from the route termini, but also from intermediate points, say, every half mile or so, where lock-up telephone boxes fixed, if need be, to the poles, are available to the conductors, who should each be provided with a key. The train or car dispatcher ought, therefore, in our opinion, hardly to take the place of the traffic manager, though he may very well exist as a subordinate in the latter's absence should emergency arise.

The system developed at Los Angeles, however, is well worth careful study, if not full adoption; it is remarkably well designed to give every facility for saving time—that is, money. The wires leading from the distant telephones run into the dispatcher's office, and are there connected to a glass front switchboard about 20 × 12 × 8 inches in size, on the top of an oak desk some 9 feet long, and capable of use by two operators at the same time if necessary. The transmitter hangs in front, as usual, for exchange work. "A system of magnetic and gravity drops operates in connection with a signalling system of small incandescent lamps, the latter being placed behind stencilled numbers representing the circuits, so that when lighted they indicate the circuits ringing up. Various cam lever switches worked by the operator's left hand restore the drops to their normal position, put out the lamps, and place him in direct communication. In front, on the desk is a large sheet, 21 × 24 inches, on which are listed the numbers of all cars in their regular order, under the proper headings of each line. The operator can dispatch two to seven cars per minute, recording the time each one should leave the terminus on his sheet. A glance at this sheet gives him the immediate condition of the entire system and exact location and direction of each car.

"Of course, the calls do not come in uniformly, but vary a great deal, according to the number of cars in operation. The space between cars also varies, as does the number of cars in operation, which is governed by the traffic at different hours of the day in most places.

"The watches of all the trainmen are compared from one to three

times a day, and kept regulated with the large clock in the dispatcher's office, which gives the standard time of the system, and governs the movement of all cars.

"The dispatcher is held responsible for the movement of each car. All report to him on each trip between 6 a.m. and 12 midnight from the ends of their respective lines. No time-card whatever is used where this system is employed. The cars are started in the morning from the various depôts at a certain hour, and are allowed so much time in which to run from the depôt to the end of the line, where they report to the dispatcher, and from him obtain their leaving time from such point. Different schedules of running time between points are employed at different hours of the day, owing to the demands of the traffic. These schedules are regulated by the dispatcher. 'Extra cars' and 'trippers,' before leaving the car houses at different hours of the day, in all cases report to the dispatcher, giving him their car number, and the line upon which they are to run. In reply he gives them the leaving time and direction. The moment that a report is received giving notice of a block, the dispatcher ascertains the number of the car, and a glance at his sheet gives him the direction going, whereupon he immediately begins to lengthen the space between the cars ahead of the delayed one as fast as they report, taking into consideration the nature of the delay, and about how long it will continue. In the meantime he may have summoned either the wrecking car or waggon. Then, the moment he receives the word that the block is raised, another glance at his sheet and the large clock in front of him, gives him the exact location of each car, when, as fast as they report, he begins to despatch them from the ends on their regular headway."

By means of electric calls on telephone circuits, he is in immediate touch with all the car houses, shops, offices, and leading officials, so that on a moment's notice any member of a department may be rung up and summoned to any point. So complete, indeed, is the control exercised by the dispatcher, that he might well be forgiven for getting a swelled head and looking upon himself as the most important man in the whole company or system.

We hardly think there will be much scope for the full employment of a method like the above in this country, ingenious and partially useful as it undoubtedly is; even in ordinary tramway companies there is a surfeit of head cooks to spoil the broth. When municipal tramways flourish the car dispatcher—if he ever exists—will require a sash or insignia of office as large as that of the Mayor!

BRIDGES FOR TROLLEY ROADS.

The *Railroad Gazette* prints an article by Mr. Chas. F. Stowell on bridges, which has been written because of the many accidents to bridges that have been made to do duty for electric lines though only built for horse cars. English bridge building has shown few failures, even though many old cast-iron girders have been allowed to survive from the early days, instead of being replaced by wrought-iron, but there have been no failures of modern bridge superstructures. But Americans have been so busy pointing out the faults of English bridges and their unscientific clumsiness, that they have had no time to look at home. The American bridge really is scientifically designed from the data allowed, but unfortunately the data have been all wrong, and designs have been made for the wheel loads in pounds, for given wind pressures and centrifugal force, and all that sort of thing, and yet bridges have fallen like autumn leaves, and even their good principles have failed to uphold them. The reason was obvious for years, but few of the designers could or would recognise that their nominal stresses were absolutely at fault, and that the question of impact had been merely played with. It was plain enough, the floor beam hangers showed it, the track stringers shouted it aloud at every end, but it is only now that their bridges have been practically anglicised, and that the despised English plate girder has been allowed to be superior up to a much greater span than formerly. But American railroads have at last grasped the facts, and a modern American bridge is something to be proud of. From Mr. Stowell's article it would appear that the trolley roads are going through the same experience. In many cases the bridge agents are allowed to offer their own plan and specification, and the bridge goes to that one who will cover the opening for least money—the inference being that the agent endeavours to provide a structure that will last until he has got out of rifle shot. Mr. Stowell likens the system to a man who would advertise for a horse 5 feet high and 8 feet long, and leave the vendor to fill in all the between particulars, and states that any one of the accidents now happening would not have happened if the bridge had been given the same care as is given to the purchase of a horse. The car's loads, for example, are given as the seating capacity, quite ignoring the treble or even quadruple loads that are often carried. There is no allowance for the pitching action of a car that may seriously increase the load on one axle; nothing is allowed for impact, or for the fact that a coal or freight car will be run over the road whenever required. It is perhaps true that the English Board of Trade has been responsible for a good deal of obstruction to progress, but in respect of bridges and railways generally we have secured a safety that American conditions have notoriously failed to secure. It is as well to be forearmed. The extension of electric lines in country places would find many local bridges incompetent to carry the new loads to which they might be subjected, were a strict eye not kept upon the needs.

THE LOCAL GOVERNMENT BOARD AND ELECTRIC LIGHTING SYSTEMS.

The history of the obstruction of the Corporation of Eccles to the electric light, based largely upon political differences, is somewhat interesting and instructive. In May, 1894, the Eccles Corporation engaged Dr. Hopkinson to report to them on the possibilities of electric lighting paying its way in Eccles. In his report to them he stated that if the street lighting were undertaken, there would be no doubt as to the financial success of the scheme, and went on to say that if electricity were supplied for private lighting alone, the scheme would probably take some years to put on a sound financial basis. He also drew up an approximate estimate, showing the capital outlay required for a low tension scheme.

The Corporation being satisfied with this report in April, 1895, engaged Mr. Clirehugh to prepare a scheme for carrying out the work. He went carefully into the matter, and as a result, reported to the committee that, in his opinion, the capital outlay requisite to carry out the proposed scheme on a low tension system would be prohibitive; he therefore advised the Committee to adopt a high tension alternating current system with transformers buried in the footpaths, from each of which incandescent lamps of 200 volts would be supplied in parallel.

The Committee approved of this scheme, and a specification was prepared and tenders obtained for carrying out the work. About this time considerable opposition sprang up owing to the constitution of the Council undergoing a change, and, as a consequence, when the Committee presented their report to the Council asking that application be made to the Local Government Board for borrowing powers, the Council were equally divided, and the resolution was only carried by the casting vote of the Mayor. From that time forward electric light, or no electric light, became a party cry on which the November elections were fought. As a result of these elections, there was no longer a majority on the Council who wished for electric light, but as the Board of Trade's approval of the scheme has been received and the date appointed for the Local Government Board inquiry, it was too late to draw back. The opposition, which was really the Corporation, engaged counsel to practically oppose their own application, with a result that borrowing powers were refused on the following grounds.

1. That there was considerable opposition to the scheme among the ratepayers.
2. That the majority of the Council were opposed to it.
3. That the site was unsuitable, owing to the existence of certain covenants against nuisance.
4. That the scheme was unsuited to so compact an area, and that a low-tension scheme, with accumulators, should be used.

Reasons 3 and 4 seem to us absurd, since the town clerk advised the inspector that the covenants were not a bar to the existence of the station, and since the borough of Eccles is one of the most scattered from an electric light point of view, which is amply confirmed when it is mentioned that the area is 2,030 acres, with a population of 30,000 persons, and that the scheme involved the lighting of 21 miles of streets tenanted for the most part by the poorer class of inhabitants.

It seems to us a matter of considerable doubt whether it is within the province of the Local Government Board to object

to a scheme on such grounds, having regard to the fact that the inspector was not an electrical engineer, and therefore obviously not qualified to form an opinion without going all over the district.

If the Local Government Board are going to take upon themselves the question of deciding what is the proper system for a district, we are afraid considerable difficulties will arise. The matter is a very serious one for the electrical industry, and we shall be glad to have the views of electrical engineers on the subject.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Sep. 8th, 1895.	£	s.
Algoa Bay	494	0
Albany. Teleph. mtl....	40	0
Amsterdam	35	0
Buenos Ayres	271	0
Bremen	20	0
Bombay	197	0
Calcutta	72	0
Cape Town	220	0
East London	194	0
Fremantle. Teleg. mtl.	814	0
Gothenburg. Teleg. wire	33	0
Lourenco-Marques. Teleg. mtl.	534	0
Otago	52	0
Port Said	14	0
Port Natal	112	0
Rosario	142	0
Sydney	75	0
Valparaiso	76	0
Total	£3,395	0

Week Ending Sep. 8th, 1896.	£	s.
Aden	391	0
Alexandria. Teleph. mtl.	221	0
Amsterdam	50	0
Antwerp. Elec. fuses	326	0
Bangkok. Teleg. mtl....	324	0
Buenos Ayres. Teleg. mtl.	470	0
Cape Town	546	0
„ Teleg. mtl.	86	0
Copenhagen	20	0
Demerara	18	0
Durban	545	0
Flushing	42	0
Fremantle. Teleg. mtl.	125	0
Gibraltar	13	0
Gothenburg. Teleg. mtl.	48	0
Hamburg	10	0
Labuan. Teleg. mtl. ...	29	0
Lisbon. Teleg. mtl. ...	24	0
Malta	93	0
Melbourne	388	0
„ Teleg. mtl....	593	0
Ostend	40	0
Penang. Teleg. mtl. ...	93	0
Perim. Teleg. mtl.	34,887	0
Port Elizabeth	546	0
Rosario	135	0
Shanghai	47	0
Seville	9	0
Singapore	432	0
Stockholm	219	0
„ Teleg. mtl....	294	0
Sydney...	340	0
Vera Cruz	27	0
Wellington	824	0
Total	£42,255	0

Foreign Goods Transhipped.

	£	s.		£	s.
Auckland...	35	0	Townsville	1,534	0

American Meters.—The Fort Wayne Electric Corporation, of Fort Wayne, Indiana, have sent us lists of the Duncan alternating current recording meters. A number of illustrations, showing inside and outside views, also meter connections, are given, and prices also appear in the lists.

Bankruptcy Proceedings.—The *London Gazette* contains notice to the effect that Mr. E. Cecil Moore, of 3, Crosby Square, London, E.C., has been appointed trustee in the matter of Paterson and Cooper's bankruptcy.

Dissolutions of Partnerships.—Messrs. T. S. Taylor, W. Taylor, and H. W. Hobson, carrying on business as scientific instrument makers at Slate Street, Leicester, and No. 8, Charing Cross Road, London, under the style or firm of Taylor, Taylor and Hobson, has been dissolved by mutual consent. All debts will be attended to by T. S. Taylor and W. Taylor, who will continue to carry on the business.

Messrs. J. A. Russell and R. F. B. Lennard, trading as electrical engineers and contractors, under the style of Russell & Lennard, dissolve partnership by mutual consent. On and after Saturday, the 12th inst., Mr. John A. Russell will trade as Russell & Russell, at 49, Victoria Street, S.W.

Liquidation Notice.—A general meeting of the Improved Electric Glow Lamp *Syndicate* is to be held at the offices of the Improved Electric Glow Lamp *Company*, 103, Queen Victoria Street, E.C., on October 16th, at 11 a.m., for the purpose of having an account of the winding-up of the syndicate laid before it.

Catalogues, &c.—A list of the standard Wheatstone Bridge Box, 1896 pattern, which has been designed to meet a demand for a reliable bridge having a large volume of wire, and being thus capable of employment with comparatively large currents, has been sent to us by Messrs. Elliott Brothers.

A price list of electrical accessories and electric light fittings has just been brought out by Messrs. A. Vandam & Co. Each alternate page throughout the book is devoted entirely to illustrations of the firm's specialities. The other pages contain a detail or two regarding the articles, the prices of each being arranged in a table on the right. On each page a good deal of space has been left, sufficient, we presume, for the purpose of making additions at any time. As might be expected, switches occupy a number of pages; lamp-holders, incandescent lamps, reflectors, arc lamps, measuring instruments, fancy shades, and a variety of pendants and electroliers, are the chief items.

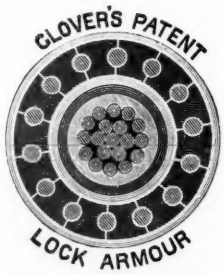
The Newton Electrical Works, Limited, has issued a price list dated 1896, which contains photos and full details of the Taunton and Taunton-Willans dynamos, high-speed gas and oil engines, with dynamo direct-coupled; Taunton type of launch, and commercial motors; switchboards and switches, and alternating transformers. Some useful instructions for fixing and working motors are given at the end of the book.

Change of Address.—Messrs. Calvert & Co., electrical engineers, &c., have removed from 24, Exchange Buildings, to larger premises at 4, St. Mary's Street, Manchester.

Engineer's Tools.—Messrs. Wilhelm & Co., of Wool Exchange, Coleman Street, E.C., who are the sole agents for the United Kingdom for the "Hard" incandescent lamps and "Weinert" arc lamps, are also the representatives of Messrs. Wm. Kücke & Co., of Elberfeld, who make a speciality of electricians', telegraph, and other engineers' tools, also tool wallets, and insulating material. A list of their varieties is before us, and includes pulleys, pliers, borers, clamps, spanners, &c.

For Sale.—Messrs. Vaughan & Son, of the Royal Ironworks, West Gorton, Manchester, have for disposal a Vaughan 10-ton overhead rope-driven traveller, 20 feet 6 inches span, also a 6-ton rope-driven walking jib crane.

Lock Armour for Electric Light Cables.—The illustration shows Glover's patent high conductivity lock armour for electric light cables, which has been designed to meet a want in cables having what is termed a "bare return." If ordinary iron or steel wire armour is used for the purpose of conveying energy (particularly in cables of large size), the weight of such metal required to accommodate the current is so great, viz., about seven times that of copper, that the cables are both costly and unwieldly. The patent lock armour is designed to overcome these disadvantages. It will be observed that the cables are completely sheathed with the iron or steel segments forming the lock armour, the round wires being of copper, which greatly increases the conductivity of the armour, thus reducing its



weight, and at the same time giving a complete armour, which is far superior to that of round wires. The surface of the lock armour being smooth and continuous, enables the cable to be nicely finished, and at the same time protects the cable from accidents by picks or sharp instruments or stones, which might otherwise force their way through a round wire armour. Cables having an "earth or bare return" are frequently used in coal mining, mill lighting, ship lighting, &c. Messrs. W. T. Glover & Co., of London and Manchester, manufacture these articles from the smallest to the largest sizes required for lighting purposes. The length in which such cables can be supplied is practically unlimited.

Messrs. Fletcher Hirst & Co.—This firm (of Burnley) have opened a branch business at Chester, and their address there is the Northgate Electrical Works, Victoria Road, Chester. Messrs. Hirst are at present fitting, for the electric light, the Wesley Chapel, Mount Pleasant Chapel, the Mechanic's Institute, and the Technical Schools, Burnley, also the Rochdale Public Free Library, Red Lumb Mills, Rochdale, Purcy Slipper Works, Waterfoot, and the Peel Mills, Rosegrove; the latter is a new mill, and is said to be the largest weaving shed in the world.

Outing.—The employés of the Incandescent Electric Lamp Company, Limited, had their annual outing on Saturday last. The party, numbering over 150, accompanied by the manager, Mr. C. J. Robertson, proceeded to Hastings. Dinner was served in the Central Hall.

ELECTRIC LIGHTING NOTES.

Aberdeen.—George Street is very badly lighted, and a memorial has been presented to the Town Council, by shopkeepers and others, requesting that the thoroughfare be lighted by means of overhead electric lamps.

The extensions to the gas and electricity works are now nearly completed. The electric lighting station is being made twice

its original size, and the plant now being laid down will bring up the capacity to 3,000 H.P. A 300 H.P. engine and dynamo, and two 600-H.P. boilers, are being added, and are expected to be ready before the end of the year.

It is proposed that a row of electric lamps shall be erected about the middle of the quays, of such power, height, and distance apart as to provide sufficient light over the whole area. Provision will at the same time be made for the supply of portable arc or incandescent lamps to the shipping when desired. The cost is estimated at £9,336.

Belfast.—The Electric Light Committee finding the long-spoken-of additional plant necessary, are now in treaty for the supply of an additional engine and dynamo (direct driven). With a view to encouraging the use of electricity during the day time, the Council has resolved to reduce the rate for current used over 4,000 units to 2¾d.

Bexhill.—Unless the electric lighting company agrees to the insertion of a clause in their Bill, enabling the Council to purchase at any time by arbitration, the latter will oppose.

Blackburn.—It is proposed to appoint another assistant electrical engineer at £125 per annum, to meet the additional work caused by the extension of the Corporation electric lighting installation.

Blackpool.—The Electric Lighting Committee has given instructions for the tramcars to be lighted electrically. Messrs. Crompton & Co., Limited, have the contract for the supply of 50 new arc lamps, with fittings complete, for the new electric lamps in Lytham Road. It had been hoped that everything would be in readiness for the use of the lamps ere the end of the present season, but a delay in fixing the new machinery will prevent it.

The annual statement of the Blackpool Borough Treasurer, which was issued recently to members of the Council, gives some interesting statistics as to the electric lighting undertaking of the Corporation. The capital outlay on the works during the year was £8,297. The amount received for current supplied was £8,081, but the profit only amounted to £281. Interest and sinking fund absorbed £2,604; coal, coke, &c., for generation, cost £1,702; oil and waste, £250; stores, £216; water, £249; wages of stokers, £298; wages of enginemen, £410; wages of electricians, £409; salary of electrical engineer, £250; clerks, £135; repairs, £459; and attendants, £106.

Boston.—The Council has approved of the action of the Lighting Committee in authorising the expenditure of £25 in obtaining the opinion of an expert *re* an electric light scheme.

Bradford.—The Council is at present considering the further extension of the electricity supply, the Electricity Committee having made a recommendation regarding an extension of the mains.

On the 8th inst., the Chairman of the Gas and Electricity Committee, in presenting the accounts for the six months ended June last, said that in the electricity department notable strides forward had been taken. The price of the current had been lowered from 3½d. per unit to 2½d. per unit for use in motors. The trade profit had been £3,578, as against £3,176—the net profit being £1,007, compared with £986, or 1·19 per cent. on a capital outlay of £84,351. The committee had supplied 35,954 Board of Trade units during the half year. Altogether the total net profit of the committee had been £8,557. The minutes were adopted.

Brighouse.—In our reference to the new settlement arranged by the Brighouse Corporation and Mr. A. B. Brook, we omitted to say that Mr. Edwin Blakey, of Bradford, has acted on behalf of the Corporation in the matter of the valuation, and as their electrical adviser in this matter.

Brixton.—The new Brixton Theatre, which will be opened in a few days, is fitted throughout for electric lighting.

Colchester.—A Local Government Board inquiry was held on Friday last regarding the Corporation's application to borrow £15,000 for electric lighting. Mr. W. H. Massey, the consulting engineer, and the borough surveyor, gave details of the scheme. There was a little opposition.

Combe Down (Bath).—The lighting question is being considered by a sub-committee. At the last meeting of the Council a member proposed that, as it was possible they would soon have the electric light there, they only accept tenders for six months for repairing the present lamps.

Croydon.—The central station works have progressed so far, that one dynamo is already in position, and a trial start was to have been made on the Thursday of last week; but in consequence of the heavy rains and the low lying district in which the works are situated, the latter became flooded so far as regards the boiler house, trenches and flues. A steam fire engine was brought into service and the water drawn off. The flues are connected with a temporary iron shaft, and it was contemplated to retain this until the destructor scheme had matured, and then erect a permanent shaft which would answer for the two. However, it has now been decided to put up a separate shaft for the present works, the erection of which will be entrusted to a Bristol firm. The distribution mains for the compulsory area, which are armoured and laid direct in the ground, have been in position some months.

On Monday night current was turned on at the municipal building. The Town Hall contains 1,000 lights of 16 C.P. each.

Dewsbury.—The borough electrician states that there is a deficit for the half year of £139, but the annual statement is expected to show that they were on the right side. It has been agreed to extend the electric mains to Wilton Street.

Droitwich.—The Council has decided to extend the gas works in spite of the protests of several members who thought the adoption of the electric light probable.

Dudley.—On Tuesday, the question of electric lighting came before the Town Council, a proposal to apply for a provisional order being before the meeting. A Committee has been in communication with a number of towns where Corporations have their own installations, and they recommend a similar course, estimating the cost of a plant suitable for Dudley at £25,000. Mr. F. Harman Lewis, the borough electrical engineer at Wolverhampton, reported to the Council regarding his inspection of Dudley on August 19th. He says the Council could make a commercial success of an installation, if properly managed. The Council, after considering the matter, appointed a committee to go into the whole question.

Dundee.—During the four months ended August 31st, the electricity rental collected amounted to £786 13s. 7d., as compared with £696 3s. 1d. last year, or an increase of £90 10s. 6d.

Edinburgh.—The Electric Light Committee estimates for 1896-7 are as follows:—Estimated expenditure for 1896-7 is £20,325. The actual expenditure for 1895-6 was £13,985 18s. The expenditure is made up under the following heads:—Generation of electricity, £5,425; distribution of electricity, £835; public lamps, £1,740; rents, rates and taxes, £1,220; expenses of management, £1,635; interest and contribution to sinking fund, £9,470. The estimated revenue for 1896-7 is £24,745. The estimated revenue for 1895-6 was £12,640, and the actual, £16,721 4s. 6d. It is made up as follows: Sale of current by meter, £16,500; charges for arc lamps, £7,875; other sources, £100.

Electric Lighting of Trains.—The Caledonian Railway Company have had one of their trains fitted up with the electric light on Messrs. J. Stone & Company's system.

France.—A central station has just been completed and put in operation at Allassac (Correze). The plant comprises a 115 H.P. Hercules turbine, and an alternating current dynamo, giving 25 amperes at 3,000 volts.

Garston.—Mr. Medhurst has submitted a report upon the subject of supplying electricity to the district in conjunction with a refuse destructor, and the Special Purposes Committee recommend that the scheme suggested be adopted; also that the law clerk take steps to acquire a provisional order from the Board of Trade, apply to the Local Government Board for permission to borrow £25,000 to carry out the scheme, and advertise for a site for the proposed works.

Glasgow.—The warehouse of Messrs. W. & J. T. Costigane, Granite House, Glasgow, is to be lighted throughout with electricity by Messrs. Wm. Ramsay & Co., of that town. The contract included 11 10-ampere 2,000 C.P. arc lamps for lighting a range of windows in Trongate and Stockwell Streets on the outside, 15 3-light clusters of 150 C.P. for the inside of windows, 14 clusters of 75 C.P. electric incandescent lamps for lighting up counters inside of warehouse, one 3-light cluster for cash desk, one 3-light cluster for main stair, 14 3-light clusters for mantle department, &c. Messrs. Ramsay are also fitting outside the Bonanza Warehouse, Argyle Street, eight 2,000-C.P. arc lamps.

The same firm have received the contract to fit the electric light on an extensive scale in the Liberal Club, Buchanan Street. The installation will include the lighting of halls, dining room, reading room, card room, billiard room, smoke room, staircases, &c.

Glasgow.—The Bazaar Committee is to obtain tenders for the electric lighting of St. Andrew's Hall.

Halifax.—The Corporation recently referred it to a Committee to consider whether it was advisable to reduce the price per unit. The Committee recommends that the question be deferred until the end of the year.

Hammersmith.—Messrs. Leslie & Co. report that they are unable to complete their contract for the chimney shaft within the time arranged if the glazed fire-clay is required for the plinth, as it will take three months to make. The Vestry has therefore agreed to the substitution of Bramley Fall stone, which will effect a saving of about £60. The matter will be again looked into with a view to adjustment on completion.

Hanley.—The enlargement of the electricity works is now nearly completed. The demand for the light is steadily increasing. Shortly the capacity will be equal to 15,000 lamps, a large portion of which had been taken up.

Hastings.—The Council has approved of plans drawn up by the Hastings and St. Leonard's-on-Sea Electric Light Company for a transformer pit to be placed near the public library, and for mains to be laid in London Road.

Leatherhead.—A Councillor has given notice to move a resolution applying for an electric lighting provisional order.

Leith.—The Council has instructed its Electric Lighting Committee to take the necessary steps for applying for a provisional order. It is estimated by Baillie Manclark that £25,000 would cover the initial outlay, and £2,700 the annual expenditure.

Levenshulme.—The South Manchester Electric Supply Company, Limited, having given the Council notice of its intention to apply for a provisional order for lighting this district, a councillor has given notice that at the next meeting he will move that the Council undertake the work itself.

Leyton.—A Local Government Board inquiry was held on Thursday last week regarding the Council's application to borrow certain sums of money, which included £210 for wiring and fitting the public library for electric lighting.

The municipal electric lighting plant will be completed shortly. We hear that current was turned on at the Town Hall for a short trial last Friday.

Liverpool.—The City Council last week agreed to make the reductions in the charges for current as proposed by the Lighting Committee. A correspondence is going on in the Liverpool press regarding the unfairness of the reduction, which is declared to only affect very large firms who can afford to pay more. The decision of the Council to carry on wiring and fitting is also criticised.

London.—Finsbury Park Congregational Church has been redecorated, and the electric light is now supplied throughout.

An installation of the electric light is being carried out at the Roman Catholic Cathedral in Southwark.

Northwich.—The District Council has sealed an agreement with the newly formed Northwich Electric Supply Company, who have applied to the Board of Trade for powers to supply electric light in the rural and urban districts. The agreement is understood to give the Council the option of purchasing the concern at the end of 14 years, on repayment of expenditure incurred in buildings and plant, and "the payment of 7½ per cent. for any years a less dividend has been declared."

Shoreditch.—Acting upon the recommendation of its lighting committee, the Vestry has resolved to put down a "motor-transformer station" at the junction of Great Eastern Street and Curtain Road. Also to undertake the wiring and fitting of consumers' premises and the supply of electrical fittings. For this purpose a show room is to be opened, and the necessary arrangements are in the hands of the Lighting Committee.

South Africa.—The *British and South African Export Gazette* for September says that the Kimberley Borough Council has resolved to call for estimates in England for an electric lighting plant capable of supplying 2,000 electric lamps for the lighting of private houses, with power to work 4,000 if necessary.—An electric lighting installation is on order for the Bultfontein United mines.—An electrical pumping plant is to be obtained for the Vogelstruis Deep.—The Standard Buildings Company, Limited, Johannesburg, have ordered an electrical installation, at a cost of about £6,000, for the new buildings which they are erecting.—A 300 H.P. electrical installation for lighting, driving the pumps, and other purposes, is under order for the Balmoral mine.—Messrs. Fuchs & Co. are understood to have entered into a contract to supply the Johannesburg Sanitary Board with incandescent lamps.

Spalding.—A communication from a firm of electrical engineers asking whether the Council would not have the Infectious Hospital lighted electrically, seems to have occasioned considerable merriment among the members, and they forthwith declined to entertain the application.

Tonbridge.—The Electric Light Committee is making inquiries as to the amount of support which would be received if works were established for the supply of electricity in the town. In the meantime the committee has been authorised to expend a sum not exceeding 20 guineas in obtaining the report of a competent electrical engineer as to the probable cost of works and plant, the best system to be adopted, the areas of supply, and the approximate expense of maintenance.

Tunbridge Wells.—At a recent council meeting it was stated that, although the electric light installation had not yet been running for a year, the proceeds paid the sinking fund and the interest, and there would soon be a profit.

Wells.—The electric lighting scheme having been approved, the Town Clerk reports that Dr. Hopkinson is preparing plans to support the application for sanction to a loan.

Wigan.—A councillor complained the other day of the delay in introducing the electric light. In reply, it was stated that this was due to the prolonged illness of the late Alderman Smith, who was for many years Chairman of the Gas Committee.

Yarmouth.—The amount expended on these works since they were begun, to December 31st, was £20,232 0s. 10d. The receipts for the same term totalled up to £18,707 12s., showing a difference of £1,524 8s. 10d. against the borough. For the year ended March 25th, the revenue amounted to £1,914 17s. 1d., and expenditure, without interest or sinking fund, £1,765 9s. 7d.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Algeria.—A company has just been formed in Paris with a capital of £64,000, to be known as the Société des Tramways Algerieno. The French Thomson-Houston Company is largely interested in the new undertaking.

Blackburn.—The Blackburn Tramways Company have decided in favour of the adoption of electric power on two sections of their line, and the directors of the concern have been empowered by resolution of the shareholders to make the best terms possible with the Blackburn Town Council for a supply of the motive power. The Corporation are contemplating considerable extensions in connection with their electric lighting undertaking, and the Tramway Company being approached on the subject of electric traction for the trams, favourably considered the project, as announced above. It may be mentioned in connection with this matter that horse-power on the proposed routes costs 5·95d. per mile, whilst electric traction, including maintenance, repayment of principal and interest on the purchase of new cars, &c., is calculated at 4·65d., the difference in favour of electricity being therefore 1·30d. a mile. The Corporation offered to lay down an installation and supply current at an inclusive cost of 3d. per mile, and this it was shown would effect a considerable saving to the Tramway Company.

Germany.—The Union Electrical Company of Berlin have secured a concession for the construction and operation of an electric tramway in the town of Meissen on the overhead-conductor system. Gas engines are to be used to drive the dynamos at the power station.

Glasgow.—We learn that the Tramway Committee, on Wednesday, resolved to recommend that the tramway manager and engineer should be sent to America to inquire further regarding electric tramway motors. They will come back and Glasgow will have its electric trolley tramways, but there was no need to throw away further money in a trip to the States.

Nottingham.—The Town Council is to introduce a Bill into Parliament, seeking power to work its tramways by mechanical power instead of horses. A Committee is to consider the question of the best motive power, and, if necessary, will visit various places to see systems in operation.

Shoeburyness to Southend.—An electric tramway is proposed to run between these two places. The Shoeburyness District Council has agreed to consider the question of constructing such a line. The success of the Southend pier line should be a good object lesson for them.

The Transvaal.—According to a cable received in London on Tuesday last, from Johannesburg, the Government has sanctioned a scheme for providing the Rand with a comprehensive scheme of electric tramways, for the purpose of connecting Johannesburg with some of the populous suburbs along the main reef.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Para-Maranham	Aug. 6th, 1896 ...	...
Zanzibar-Mombassa	Aug. 23rd, 1896 ...	Sept. 5th, 1896
Bahia-Rio de Janeiro ...	Sept. 4th, 1896 ...	...
Penang-Medan	Sept. 7th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol (Mashonaland)	March 12th, 1896 ...	...
Communication with Cartagena and Barranquilla, Columbia.	July 4th, 1896 ...	...
Salisbury-Umtali (cutting off communication with Beira)	July 10th, 1896 ...	...
Siberian lines between Omsk-Irkustk	Sept. 6th, 1896 ...	Sept. 7th, 1896
Siberian lines between Tschita-Nertschinsk	Sept. 7th, 1896 ...	Sept. 8th, 1896

Telegraphs in Northern Siam.—The British consul at Chiengmai, Northern Siam, in his report for last year, states that the telegraph lines are lamentably neglected: "That to Bangkok has not been open for a year owing to the want of a few repairs or chemical appliances."

The Ceylon Telegraphic Service.—The telegraphic arrangements of this island, according to *Indian Engineering*, are fearful and wonderful. The system of delivery is wretchedly bad. Mr. E. O. Walker, Superintendent of Telegraphs, talks of changing all this. The extra wire to Nuwara Eliya will, it is said, be ready in about a month. The wire to Putlam and Manaar will probably be in working order three years hence. There is no "wire" to spare and no timber to be had. It may be added that Mr. Walker is at present engaged, by direction of the Royal Society, in experiments dealing with the extraneous currents which every telegraphist wots of. *Indian Engineering* is inclined to be sarcastic at Mr. Walker's expense, but it should not be forgotten that he has not long been in office. He will do all he claims to carry out.

The Stockholm Telephone Exchange.—"Hermes," in an article in *Commerce* regarding the commercial affairs of Norway and Sweden, gives a good illustration of the Stockholm telephone service, which we believe will be of interest to our readers. We are indebted to our contemporary for the loan of the block.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 28th. The Société Nationale des Chemins de Fer Vicinaux, in Brussels, is inviting tenders for the conversion of about 23 kilometres of "Vicinal" railways in the Charleroi district, into electric lines on the overhead conductor system. Particulars may be had for 1 fr. from, and tenders to be sent to, the Société Nationale des Chemins de Fer Vicinaux, 26, Rue de la Science, Brussels.

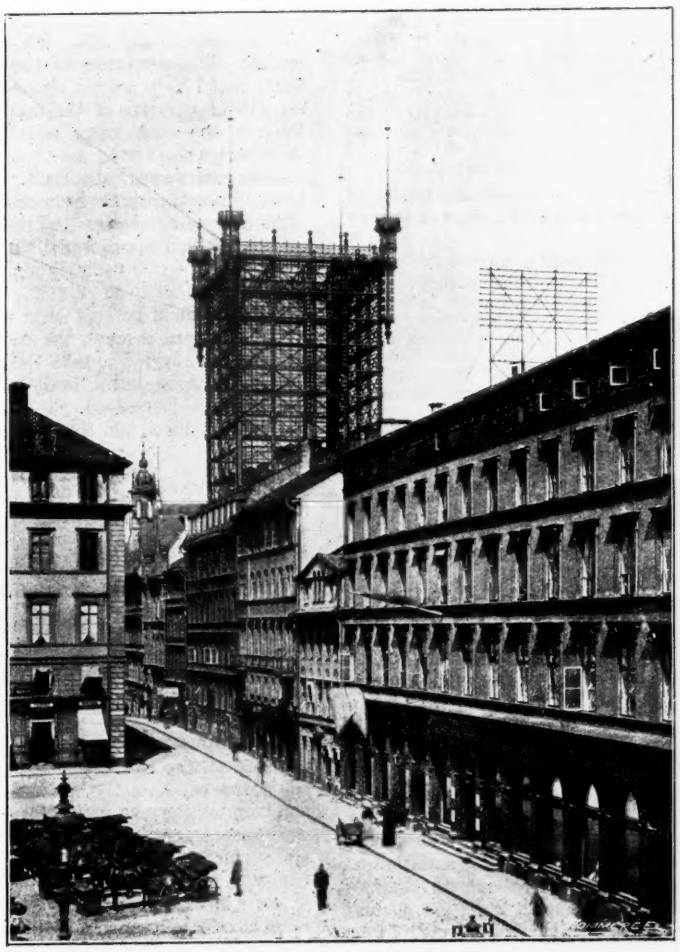
Belgium.—September 15th. Plans and tenders are being invited by the Municipal Authorities of Spa, for the lighting of the public streets by electricity, or by acetylene. Tenders and schemes are to be submitted to the Collége des Bourgmestre et Echevins, Spa.

Edinburgh.—September 22nd. Tenders are wanted for the wiring of the Burgh Assessments Office, High Street. Particulars from the resident electrical engineer, 5, Dewar Place. See our "Official Notices."

Madras.—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

Madrid.—October 8th. The Secretary of State for Foreign Affairs learns from her Majesty's Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez in Porto Rico. October 8th is the date fixed for the consideration of tenders, and such particulars as her Majesty's Government have received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Morley.—October 14th. From our "Official Notices" particulars may be obtained of boilers, engines, dynamos, alternators, &c., for which the Electric Light Committee invites tenders.



The Stockholm Telephone Exchange.

Cadiz.—September 15th. The Secretary of State for Foreign Affairs has received despatches from Her Majesty's Consul at Cadiz, stating that preliminary tenders for a supply of electric lighting apparatus for the illumination, on the most approved modern plan, of the private houses, &c., in the town of Cadiz, are invited by the "Sociedad Co-operativa Gaditano de Fabricacion de Gas." Tenders should be sent in by September 15th, to the above-named company, whose offices are San José, 25, 27, and 29, Cadiz. Firms wishing to obtain the contract for the supply of plant are advised by the Consul to send representatives to treat personally with the company. Such additional particulars as have reached Her Majesty's Government on the subject, may be viewed at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Edinburgh.—September 22nd. Tenders are invited by the Corporation for coal hoist, gantry, and capstan; coal hoppers, measuring gear, and shoots; also hauling gear in coal store for the electric supply station. For further particulars see our "Official Notices."

Oldham.—September 15th. The Electric Light Committee invite tenders for the various works required in the extension and alterations of the buildings of the electric light station in Gas Street, Oldham. Specifications, &c., to be seen on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham.

South Africa.—October 1st. The Municipal Authorities of Bloemfontein are inviting tenders for supplying and laying down a complete electric lighting installation for the town. Tenderers are to submit a complete description, with plans and specifications, of their proposed scheme to W. A. Koller, Town Clerk, Bloemfontein, Orange Free State.

Swansea.—The Council has been recommended to invite tenders for lighting the new market by electricity, according to specifications drawn up by Messrs. Kincaid, Waller & Manville.

West Looe.—A Parish meeting, held last Saturday, adopted the "Lighting and Watching" Act, and it was agreed to invite tenders for lighting the town with oil, gas, or electricity.

CLOSED.

Belfast.—The tender of Messrs. Wm. Coates & Son for the fitting up of an installation of electric light in the gasworks has been accepted by the Corporation.

Dundee.—The Gas Committee has accepted the tender of the India-Rubber, Gutta Percha, and Telegraph Works Co., (£718 1s. 9d.) for india-rubber covered electric cables in the Overgate, Wellgate, and Whitehall Street districts.

Exeter.—Out of 20 tenders received for electric wiring work at the Devon and Exeter Hospital, that of Messrs. Massingham and Co., amounting to £498 17s. 6d. has been accepted. The work will be at once put in hand, under the direction of Dr. J. A. Fleming, and Mr. Charles Cole, the architect.

France.—The contract for the supply of the iron conductor supporting poles required for the electric tramways at St. Etienne, has just been placed with Messrs. Brunon & Co., of Rive de Gier, France.

Germany.—The Altona Direction of the Prussian State Railways have just placed an order with Herr Carl Schenck, of Darmstadt, for a 12 ton electric travelling crane.

Germany.—Tenders were recently invited by the Municipal Authorities of Dortmund for the supply and erection of the boilers, engines, and dynamos required for the projected municipal central electric light station. The tenders were opened on the 1st inst., when it was found that 14 offers had been submitted for the supply of the four boilers required, the lowest being that of Messrs. A. Buttner & Co., of Merdingen, who quoted £2,475. Seven tenders were sent in for the supply of four steam engines of 400 effective H.P., the lowest being that of the Kolnische Maschinenbau Gesellschaft of Bayenthal, Cologne, their price being £6,759. For the supply of two continuous current and two rotary current dynamos, only six firms sent in tenders, the lowest offer being that of the Helios Co., of Ehrenfeld, Cologne, who quoted £3,330 and £3,061 respectively.

Rotherhithe.—The Vestry has accepted the tender of the Brush Electrical Engineering Co., for electric wiring of the new Town Hall, at £196 12s. 6d.

Shoreditch.—The Vestry has accepted the tender of the Electrical and General Engineering Co. for wiring underground conveniences at £39 odd. This firm's tender was understood to be much lower than the two others sent in. Three tenders were sent in for the supply of combined arc and incandescent lamp-posts, and that of Messrs. W. Macfarlane & Co. at £527 was accepted. Since the tenders for the plant, mains, &c., were accepted, Messrs. Laing Wharton and Down informed the Vestry that having omitted the cost of the mains to the motors in their tender of £428 odd, they must withdraw unless a variation in the specification was allowed. This would have meant an additional £100, and the Vestry, therefore, agreed to accept the next lowest tender which was sent in by Messrs. Hemingway, and amounted to £442.

NOTES.

The B.A. Meeting.—The arrangements for next week's meeting, so far as they are at present made public, are as follows:—The meeting opens at Liverpool on Wednesday evening, 16th inst., with Sir Joseph Lister's presidential address. The following morning the sectional proceedings will commence.

The President of Section A, Mathematical and Physical Science, is Professor J. J. Thomson, F.R.S. Dr. Ludwig Mond, F.R.S., will preside over Section B, Chemistry. With regard to the general work of the section, technical papers will probably occupy a large portion of Friday's meeting, including a paper and report by Professor Bedson on the "Composition of Coal." On Monday Professor Ramsay will read a paper on "Helium," and there will be a number of other communications on "Helium and Argon." Sir Douglas Fox will preside over Section G, Mechanical Science. The general programme of this section will be a fairly full one. Mr. S. B. Cotterell will have a paper to read on the "Liverpool Overhead Railway." Professor Mengarini has promised to give some account of the electric light and tramway systems of Rome. Mr. E. W. Anderson will have some "Notes on Electric Cranes," and Mr. W. H. Preece will speak of "A Test for Glow Lamps." Mr. W. W. Beaumont will discuss the question, "Why Rails Break." Professor Hele Shaw will deal with the subject of engineering laboratory apparatus, and his paper will be followed by a reception and demonstration in the Wallace Engineering Laboratory. "Horseless Carriages" will be dealt with by Mr. A. R. Sennett. There will be excursions to various places, including the Isle of Man, and a visit to the Liverpool Overhead Electric Railway.

A Bold Bid for 1,000,000 Dollars.—The following extract from the New York *Journal* is too good to be lost to English electricians gifted with a fine sense of humour:—"Walter W. Felts, an electrician and inventor from California, now living in New York, is making a determined effort to earn the $1,000,000 offered by Charles Broadway Rouss to any one who will cure him of his blindness. Now Mr. Felts suggests electrical treatment by means of a primary battery of his own invention. Experiments have been made on John F. Martin, of 192, Elizabeth Street, the blind young man who has consented to act as Rouss's substitute for the purpose, and the results achieved in a few days have awakened hope in the millionaire's breast. It is said that Martin is very slowly but surely recovering the use of his eyes. Mr. Felts's theory is that with his battery he can apply electricity in such a form to the diseased optic nerves, as to fully restore their usefulness. He claims that his battery of four cells is not subject to polarisation, and *does not transmit impurities in the passage of the current through the brain*, by which alone the optic nerves can be effectually reached. In explaining his process and apparatus, Mr. Felts said: 'It has rarely been believed by electricians that a perfect voltage and amperage with a steady current could be obtained with a primary battery, but I have demonstrated this. My cells are 6 inches by 8 inches in size. The properties of the fluids in the cells are my secret, and I have not yet obtained patents on them. I cured my wife of paralysis of the nerves of the jaw, and I think I can do the same thing with the optic nerve. I used a stronger current to the jaw than I dare do with the eye, as it must pass through the brain. As yet the highest current I have given Martin has been nearly 10 volts and 15 amperes.' 'The impression obtains that the volt kills, as in an electrocution, but this is erroneous. It is the amperage that kills. Tesla took 250,000 volts through his body, but the wonder is that he got so great a voltage with little amperage. If the voltage could be kept clear of amperage, a million volts might be passed through the body. Mr. Martin was taken to Tesla, and agreed to take 100,000 volts; but Tesla feared to pass it through his brain, as the absence of amperage could not be guaranteed. I contend that if the amperage kills, it also cures, and that is the base of my treatment.'"

Hammersmith Vacancy.—We hear that there were between 130 and 140 applications received for the post of resident electrical engineer. The Electric Light Committee is to select a few (3 to 6) of these for the Vestry to consider the matter further.

Gas.—An explosion which occurred in Haydon's Road, Wimbledon, on Sunday evening badly wrecked a house, very seriously injured three occupants, and two lads who were passing the house at the time.

The Composition of a Coin.—W. N. Hartley has determined the composition of a coin by an ingenious adaptation of the methods of spectrographic analysis. The spectrum of the coin, according to the *Scientific American*, was photographed and the metals present first ascertained, after which their relative proportions were arrived at by comparing the photograph with a series of quantitative spectra, in which solutions of known strengths yielded spectra with a certain number of lines of definite length and strength. Alloys were then made to imitate the metal, and photographs of their spectra taken in the same way. The third trial produced an alloy, the spark spectrum of which yielded a photograph identical with that of the coin, a "white" sou of the French revolution of 1798, the composition being found by the usual methods of analysis to be:—Lead, 13·93 per cent.; copper, 72·35; iron, 0·85; zinc, 12·70. By this novel method of analysis, the composition of antique jewelry and coins may easily be determined without injuring them in any degree.

Electrical Haulage Plant.—We hope in our next issue to be able to supplement Mr. Kennedy's papers on "Transmission of Power in Mines," with a description and illustrations of a haulage plant, which we have recently had the pleasure of examining at work in an extensive coal mine in South Wales, and as it is, perhaps, the largest of its kind, we think it will be found of considerable interest to our readers.

Technical Education.—The report of the Governing Body of the Battersea Polytechnic for the years 1893-4-5 has just been issued. The evening classes seem to have been very well attended, and the following abstract shows the entries during the 1894-5 session :—

Department.	Class entries.	
	January to June, 1894.	October, 1894, to June, 1895.
Mechanical engineering and building—		
General and trade classes	426	1,315
Physics and electrical engineering ...	146	287
Chemistry	32	250
Mathematics	110	261

This shows a healthy desire for technical instruction, and the advance in numbers shows that the demand is on the increase. The day classes have also been successful, the progress in numbers and in efficiency in the technological and science sections being shown below :—

	Entries.		Subjects.		Passes.	
	1894.	1895.	1894.	1895.	1894.	1895.
Technology	67	122	4	7	44	62
Science	173	322	8	13	82	214

The following table, also given in the report, is interesting, as it shows the number of entries in physics and electrical engineering. It will be observed that electric wiring students outnumber the entries for any other subject. The prospectus of classes for the 1896-7 session has been issued.

Physics and Electrical Engineering.

Subject.	Entries.
Electric lighting, L.	29
„ „ P.	27
Magnetism and electricity, L.	57
„ „ P.	49
Sound, light and heat	17
Physics for B.Sc.	10
Electric wiring	67
	256

L. Lectures. P. Practical work.

We have also received a syllabus of the classes to be held during the coming session.

The syllabus of lectures in the Engineering Department of the City of London College, White Street, Moorfields, for the 1896-7 session, has been issued, as also has the general list of classes in the usual subjects. The engineering lectures, which are in charge of Mr. Henry Adams, M.I.C.E., M.I.M.E., F.S.I., &c., comprise civil and mechanical engineering, surveying, valuation, strains in ironwork, and building construction.

A syllabus of the day and evening classes in architecture, building construction, and modern practice, to be held at King's College, London, during the coming session, has been issued, and copies can be obtained on application.

Li Chung Tang.—Our late visitor Li is having a lively time across the Atlantic. The American railway official who jammed the celebrity's finger in the carriage door, we suspect, will not speedily forget it, but now the Chinese viceroy has had a mishap for which we suppose he can blame none but himself, unless it be his walking stick. A few days ago he was shown over the immense works of the Niagara Power Company, and by chance he "placed his stick on one of the poles of a battery," and, we are told, received a severe shock, which laid him prostrate for a while. It must have been a chopstick! We hope he has completely recovered, and also that he will not hold a bad opinion of our transatlantic cousins because of his unfortunate mishaps.

Electric Miners' Lamps.—Portable electric lamps have lately been introduced in the collieries at Sekul, Hungary, in place of ordinary safety lamps. The lamps, which were supplied by the Bristol Accumulator Works, of Vienna, are each provided with a small secondary battery, the weight of the set being 2 kilog. The lamp gives from 1½ to 2 C.P., the accumulator being able to maintain this for 10 hours.

High Voltage.—A transatlantic exchange which has gathered certain information from various sources regarding the practical working of high voltage incandescent lighting, says that the experience with 200 volt lamps has been uniformly favourable, and as experience has also been equally favourable in England, "there can remain little doubt but that high-voltage incandescent lighting has before it a wide field of usefulness, particularly in smaller towns and for large, isolated installations. The lower rated efficiency of the high voltage lamp is somewhat of a disadvantage, but this to some extent is compensated for, it would appear, by a lengthy life and little drop in candle power. The difference of efficiency between low and high voltage lamps, after all, is not so great as might be thought in view of the present talk about 2½-watt standard voltage lamps. If the comparison were made with 3½-watt standard voltage lamps, it would more nearly be in accordance with actual practice at present and perhaps for a long time to come."

An Ingenious Comparison.—Dr. Arnott has compared the human body with the steam engine, and below is a copy, reproduced from the *Scientific American*, of the comparison, as given in his "Treatise on Warmth and Ventilation" :—

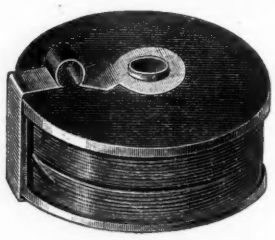
The Steam Engine in Action takes:	The Animal Body in Life takes:
1. Fuel—viz., coal and wood, both being old or dry vegetable matter, and both combustible.	1. Food—viz., recent or fresh vegetable matter and flesh, both being of kindred composition and combustible.
2. Water.	2. Drink (essentially water).
3. Air.	3. Breath (common air).
And Produces:	And Produces:
4 Steady boiling heat of 212° by quick combustion.	4. Steady animal heat of 98° by slow combustion.
5. Smoke from the chimney or air loaded with carbonic acid and vapour.	5. Foul breath from the windpipe, or air loaded with carbonic acid and vapour.
6. Ashes, part of the fuel which does not burn.	6. Animal refuse, part of the food which does not burn.
7. Motive force of simple alternative push and pull in the piston, which, acting through levers, joints, bands, &c., does work of endless variety.	7. Motive force of simple alternate contraction and expansion in the muscles, which, acting through the levers, joints, tendons, &c., of the limbs, does work of endless variety.
8. A deficiency of fuel, water or air first disturbs and then stops the motion.	8. A deficiency of food, drink or breath first disturbs and then stops the motion and the life.
9. Local hurt from violence in a machine is repaired by the maker.	9. Local hurt or disease in a living body is repaired or cured by the action of internal vital power.

North-Western Electrical Association.—The report of this Convention, which we publish on pages 347, 348, and 349, will interest all sorts and conditions of electrical men, and the newly-formed Municipal Electrical Association in particular, especially that portion dealing with the National Electric Light Association, of whose errors and lethargic condition it will, of course, steer clear. That portion of the report devoted to alternating current motors brings a new light to bear upon the way in which efficiencies and power factors must be dealt with from the central station point of view, and much good and sound advice is given in the concluding paragraphs. It is curious that Prof. Silvanus Thompson, in giving three requisites for a good alternating current motor, should have overlooked three others of apparently even greater importance, but we live and learn.

Electricity at an Iron Works.—In connection with the two new blast furnaces which are being erected on the coast near Stettin, Germany, an interesting feature is that it has been decided not only to light the plant by electricity, but that electrical energy shall be employed for the operation of the various machinery and accessories, such as the coal lift, blowers, coke tipping plant, &c. The contract for the supply of the necessary electrical plant has already been placed with Messrs. Schuckert & Co., of Nuremburg.

Text-Book Fallacies.—Text-book electricians will do well to study the articles in our current issue, and in that of August 21st, on "A Problem in Electro-Dynamics," and compilers of text-books may find their perusal of use before another edition of misleading theories is placed before those who thirst for knowledge and seek only truth.

Hartmann's Spool Wire Clamp.—To confine reeled wire upon its reel, whether it be un-annealed or spring wire, holding the wire always in proper position without the necessity of fastening its free ends, the simple and inexpensive device represented in the accompanying illustration has been patented by Charles R. Hartmann, of Jersey City, N.J. It consists, says the *Scientific American*, of a U-shaped clamp whose side members are preferably connected with the reel by a central tube or pin, permitting the clamp to be readily moved along the outer surface of the reel to any point desired. The side members are provided with loops which



serve as handles, and also as springs, holding down the portion of the clamp which extends over the outer surface of the reel, and this portion has downwardly extending flanges enclosing a pad of cork, rubber, leather, or other elastic material. The improvement is especially adapted for holding in place wire designed for use in stringed instruments, preventing the wire from springing off, and, at the same time, permitting any length of string to be readily drawn off, the wire remaining on the reel being held in the order in which it was originally wound.

Interesting.—It is stated that there are in the United States 200,000 machinists, 10,000 tool makers, 25,000 boiler makers, 10,000 pattern makers, 750,000 carpenters and joiners, 200,000 masons and bricklayers, 50,000 contractors and builders, 50,000 plumbers, gas and steam fitters, 150,000 stationary engineers and firemen, 100,000 locomotive engineers and firemen, 50,000 electric railway and light employees, 50,000 cabinet makers, carvers and wood-workers, 50,000 civil, mechanical, electrical, and mining engineers.

What "Good Will" Means.—We frequently hear, says an American journal, the term "good will" used in describing a benefit or advantage existing as a part of or in connection with a business, says an exchange. It is defined in several cases as the advantage or benefit which is acquired by an establishment beyond the mere value of the capital, stock, funds, or property employed therein, in consequence of the general public patronage and encouragement which it receives from constant or habitual customers on account of its local position, or common celebrity, or reputation for skill or affluence, or punctuality, from other accidental circumstances or necessities, or even from ancient partialities or prejudices. This is a definition given by Story and followed in several cases. Boiled down, this definition would seem to mean simply that the goodwill of a business consists in the probability that customers will continue to come to the old place of business. At best it is a sale of a mere chance, which vests in the purchaser nothing but the possibility that a preference which has usually been extended may continue.

The Electro-Harmonic Society.—It has been arranged that the six concerts of this society, to be held during the coming season (the eleventh of the society's existence) shall be held on the last Friday in each of the following months: September, October, November, January, February, and March. With a view to maintaining a high standard of musical excellence, the committee has resolved to incur increased expenditure. Notwithstanding this, members' subscriptions will be the same as heretofore.

Appointment Vacant.—The Huddersfield Corporation want a working mechanical engineer for the electric supply station at £2 10s. per week. Further particulars are given in our "Official Notices."

Ediswan Fittings.—The Edison & Swan United Company announce reductions in the prices of their key-holders and screw-holders after September 14th.

Glasgow and West of Scotland Technical College.—The 1896-7 session commences on Monday, October 5th. Special courses of instruction in civil, mechanical, mining, chemical, and electrical engineering have been arranged. For further particulars see our "Official Notices."

Electricity v. Gas in Hospitals.—The Town Council has resolved to have the Isolation Hospital lighted by electricity. What influenced the Council in coming to this decision was the fact pointed out by the Health Committee that 28 beds in the hospital were apportioned in the various wards on the basis of 2,000 cubic feet to each patient, assuming that gas was the illuminant used; but with electric lighting substituted for gas, this amount might be reduced, in which case the accommodation would be increased from 28 to 45 beds, thus obviating the necessity of future extension for many years.

"Spark-Wear."—Mr. W. Perren Maycock suggests "*spark-wear*" as a convenient term for denoting the wear and tear brought about at contact surfaces by arcing and sparking.

The "Universal" Engine Test.—In our article on the "Raworth High Speed Universal Engine" last week, we stated that the length of steam pipe between the boiler and the engine which we saw tested at Loughborough, was from 40 to 50 feet. We have since learned that the total length is 88 feet.

Electrical Engineering in Holland.—The Dutch Government has decided to operate the large locks at Ymuiden, the outer port of Amsterdam, by electricity, and has placed the contract for the supply and erection, with the necessary plant, with Messrs. Schuckert & Co., of Nuremburg, Germany. The lock is the largest in Europe, and measures 656 feet in length, breadth 82 feet, and depth 32 feet. It is stated that, altogether, 36 electromotors will be required, ranging from 17 up to 45 H.P. each.

Burglar Alarms.—The Metropolitan Tabernacle, being connected with the premises of the caretaker in Newington Butts by burglar alarms, the police were enabled, on Tuesday, to capture two men who had shortly after midnight effected an entrance to the Tabernacle, and stolen money from the boxes, consisting of farthings and foreign coins, but no buttons, which shows the honesty of the congregation.

Foreign Competition.—That instructive exhibition of foreign articles which find a sale in the British West Indian markets has been so largely attended, that it is thought many others may desire to inspect the collection; therefore it will remain open until 12th inst. (to-morrow), at the London Chamber of Commerce, Eastcheap, E.C.

Personal.—We learn that **Mr.** Elmer A. Sperry, well known in America from his pioneer connection with the electric lighting industry, and more recently from his electric railway work, has been elected president of the Civil Engineers' Club, of Cleveland, O.

Three Different Spectra of Argon.—In a recent paper in the *Monatshefte*, 1896, Vol. xvii., p. 50—56, Josef M. Eder and E. Valenta give a table of the wave lengths from λ 2,050 to λ 2,439 of the lines in the blue argon spectrum. They find, also, that in addition to the blue and red spectra, there is a third spectrum of argon which is obtained by the application of very large condensers with a large Ruhmkorff and powerful currents in the primary coil. Under a pressure of 15 to 20 mm., a brilliant white light then appears in the capillary. Under pressures of 2 to 10 mm., the third spectrum is distinguished by the fact that many of the lines peculiar to the blue argon spectrum appear more distinct, and others weaker, and that entirely fresh lines become visible. The red argon spectrum disappears completely in low pressure tubes, but appears again partially when the pressure is increased. At 20 mm. pressure, many of the lines completely coincide with those of the red and blue spectra, but whole groups of lines show a displacement towards the red end of the spectrum, although the connection between these and corresponding lines of the blue spectrum is apparent. The authors are unable to confirm Crookes's statement that the red argon spectrum is produced by the positive and the blue spectrum by the negative pole.

Some Properties of Röntgen Rays.—In a paper published in the *Comptes Rendus*, 1896, Vol. cxxii., page 186, an account is given of some experiments by Jean Perrin with Röntgen rays. The conclusions which he draws from these experiments are as follows:—(1) The rays produce developable images on ordinary photographic plates. (2) That they are not cathode rays. (3) That the opacity of the following substances to the rays increases from the beginning to the end of the list: carbon, bone, ivory, calcspar, glass, quartz, rock salt, sulphur, iron, steel, copper, brass, mercury and lead. Wood, paper, wax, paraffin and water are very transparent. (4) That the propagation of the rays is rectilinear, but that they are not refrangible, are reflected only to a slight extent, and show no evidence of diffraction.

Electric Launches on the Thames.—At Windsor, on Saturday, Mr. George Charles Vaughan, of Twickenham, was fined £5 for being the owner of an electric launch called *Marie*, which had not been registered by the Thames Conservancy.

Mr. Herbert H. Berry, in the employ of Messrs. Siemens Brothers, was summoned for navigating the *Marie* at Old Winsdor, on July 5th, without care or caution, to the danger of a double-sculling skiff. The Bench inflicted a fine of £2.

The Davy-Faraday Research Laboratory.—A photographic contemporary says that Dr. Ludwig Mond has presented the freehold of No. 20, Albemarle Street, W., which adjoins the Royal Institution, to that body for a research laboratory, which shall be freely open to a limited number of persons who have already done scientific work, or who are fitted to do it, without reference to nationality or sex. This laboratory is one of the finest in the world, and we ought to hear of some good results of this munificent gift. Lord Rayleigh and Prof. Dewar are the directors.

The American Election.—Mr. Allen R. Foote, formerly secretary of the National Electric Light Association, and later in charge of the electrical department of the 1890 census, whose figures have often been before our readers, has offered himself as a candidate on the Republican ticket for election to Congress from the eleventh Congressional District of the City of New York. He is at present editor of the *American Exporter's Journal*.

Presentations.—On Monday evening, the 31st ult., an interesting gathering took place at Wolverhampton, the occasion being a presentation to Mr. William Bulloch, C.A., accountant to the Electric Construction Company, Limited, in honour of his approaching marriage. The present consisted of a handsome silver tea service and silver salver, and in a few fitting remarks, Mr. A. B. Blackburn asked Mr. Bulloch to accept the gift with the best wishes of the subscribers, which included the technical and commercial staff both at Wolverhampton and London.

Refuse Destructors.—A report on the utilisation of waste heat generated at the refuse destructor furnaces, by Mr. D. M'Coll, the Glasgow city superintendent of cleansing, is under the consideration of the Gas and Electricity Committee.

Obituary.—The death is announced of Senator Palmieri, Director of the Vesuvius Observatory, at the age of 89 years. He was successively Professor of Mathematics at Salerno, Campobasso, and Avellino, Professor of Physics at the Royal Naval School at Naples, and Professor at the University in the same town. He was the inventor of several instruments for the observation of natural phenomena, including an electrometer for ascertaining the amount of electricity in the atmosphere.

The death is announced of Mr. Perigrine Birch, the hydraulic engineer, who has been in charge of the construction of the British Aluminium Company's works at Foyers. Mr. Birch succumbed, after a few days' illness, from erysipelas, at the age of 51.

The death of Prof. Wm. Schrader, who was head of the department of electrical engineering in the University of Missouri, at Columbia, Mo., is announced in the American electrical press. He was an Associate of the American Institute of Electrical Engineers, and one of the electrical judges at the World's Fair.

Death of Mr. Horace Marshall.—We regret to announce the death of Mr. Horace Brooks Marshall, which occurred on September 1st. Mr. Marshall was the head of the firm of publishers and newspaper agents, Horace Marshall & Son, and was the pioneer of the railway bookstall trade. Mr. Marshall was a member of the City Corporation and of the City Board of Guardians. He was a Justice of the Peace and a Fellow of the Royal Geographical Society. He was a generous contributor to the City charities and to the various institutions connected with the Wesleyan body, of which he was a highly-esteemed member; but his acts of private charity were legion, and his real goodness can be best appreciated by those who had the pleasure of personally knowing him. His loss to the cause of charity is great, but fortunately there is no doubt that the good work of the father will be continued by his son, Mr. Horace Marshall, J.P.

Autocars.—At the Liverpool Chamber of Commerce, on Wednesday, an address was delivered by Mr. W. Beaumont on "Motor Vehicles for Heavy Traffic." He looked to steam in preference to oil, gas, or electricity, as it was more elastic and adaptable to the demands of heavy traffic. He cautioned those who have horses against hastily getting rid of them, for the change would take time to come, in all of which we cordially agree.

NEW COMPANY REGISTERED.

The Edezell Gas Light Company, Limited (3,286).—This company was registered at Edinburgh on September 3rd, 1896, with a capital of £1,000 divided into 1,000 shares of £1 each, to carry on the business of producers or manufacturers of gas, electricity, or other electricity for purposes of lighting, heating, or motive power. The subscribers are:—G. B. Smith, Buctan House, Edezell, residenter, 50 shares; J. Guthrie, Swan Street, Brechin, bank agent, 30 shares; J. Shiell, Brechin, solicitor, 70 shares; J. Christisen, Gannochy Lodge, Edezell, gardener, 15 shares; G. Kidd, High Street, Edezell, clothier, 10 shares; J. Caithness, Church Street, Edezell, residenter, 10 shares; A. Ramsay, High Street, Edezell, artist, 5 shares. Director's qualification 5 shares. Registered by James Craig, Brechin. Registered office, 5, Swan Street, Brechin.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chili Telephone Company, Limited (29,252).—This company's annual return was filed on August 28th; 44,000 shares have been taken up out of a capital of a quarter of a million, in £5 shares; the full amount has been called, and £220,000 has been paid.

United River Plate Telephone Company, Limited (23,654).—This company's annual return was filed on August 5th. The capital is £500,000, in £5 shares, and 58,000 have been taken up; 16,000 are considered as paid, and the full amount has been called and paid on the remaining 42,000 shares.

London and Provincial Traction Company, Limited (46,078).—This company's statutory return has just been filed. The capital is £100,100, in 10,000 shares of £10 each, and 100 shares of £1 each. 366 of the £10, and four of the others have been subscribed for, and £10 per share has been called on the former, and 1s. on the latter. £3,610 4s. has been paid, and £50 has yet to be received.

Globe Telegraph and Trust, Limited (7,465).—This company's annual return was filed on August 18th. The capital is £5,000,000, in £10 shares. 180,042 preference and 180,227 ordinary shares have been taken up, £10 per share has been called, and £3,602,690 has been paid.

Edison and Swan United Electric Light Company, Limited (18,984).—This company's annual return was filed on August 21st. The capital is £1,000,000, in 150,000 "A" and 50,000 "B" shares of £5 each. 106,400 "A" and 23,564 "B" shares have been taken up, and 17,139 "A" and all the "B" shares are considered as paid. £3 per share has also been considered as paid on the re-remaining 89,261 "A" shares. A call of 10s. per share has been made on the latter, and £44,630 10s. has been paid.

Electrical Power Storage Company, Limited (30,313). This company's annual return was filed on August 4th. The capital is £100,500, in 100 founders' and 20,000 ordinary shares of £5 each; 66 founders' and 18,257 ordinary have been taken up, and 15,120 of the ordinary are considered as paid; £5 per share has been called on the founders, and £3 per share on the ordinary, and £9,618 7s. 4d. has been paid, leaving £122 12s. 8d. in arrears. A sum of £400 has also been paid on four founders', and 400 ordinary shares forfeited.

THE INFLUENCE OF HEAT, OF THE ELECTRIC CURRENT, AND OF MAGNETISATION ON YOUNG'S MODULUS.

In the *Physical Review* for January-February, 1895, Vol. ii., No. 10, p. 277, an article was published describing a series of experiments which had been made in the physical laboratory of Cornell University, to determine the effect of temperature upon Young's modulus for a piano wire. An electric current was used as the source of heat, and a series of different temperatures employed. The experiments showed very clearly that Young's modulus for a piano wire decreases as the temperature is raised from 15° to 180° C., and that the decrease is nearly, if not exactly, proportional to the increase in temperature. The value of the thermal coefficient was likewise determined.

There were, however, other questions which were raised rather than settled by the experiments. When the wire was heated by an electric current through a helix surrounding it, the results were quite regular; but when the current was sent through the piano wire itself, results were obtained which were so irregular that no certain conclusions could be drawn from them. Some of them seemed to indicate that the current through the wire had a very perceptible effect upon the elasticity; others made it doubtful whether there was any effect aside from that due to the heat. It seemed desirable to conduct a series of experiments by the same general method, but so planned as to distinguish between the effects due to the heat, to the longitudinal magnetisation, and to the electric current through the wire. Consequently an investigation has been undertaken by Miss M. C. Noyes, under the direction of Prof. F. P. Whitman, with a view to elucidating other obscure points. Her results are published at length in the *Physical Review*, Vol. iii., pp. 432-447. The apparatus employed was similar in all essential particulars to that used at Cornell, and described in the previous article; it was arranged in the physical laboratory of Western Reserve University.

Miss Noyes undertook ten series of experiments, and she carefully describes how these were conducted, and gives tables of her results, and illustrates them by means of curves. Those who wish to follow her through their details must consult the original paper in the *Physical Review*, as we have only space for the conclusion to which her observations lead.

Below a table is given showing a summary of the results obtained in the ten series of experiments conducted by Miss Noyes. The results for the piano wires are for temperatures ranging from about 15° to 180°; for the silver wire and the first copper wire the range was from 20° to 80° or 90°.

Kind of Wire.	Diam.	Per cent. of change in modulus for 100°.	Per cent. of permanent change in modulus.	Per cent. of change elastic limit for 100°.
	mm.			
Piano wire	0·40	5·0	...	...
Piano wire	0·26	4 6	...	...
Piano wire	0·45	4 6	...	...
Piano wire	0·49	4·3	...	...
Average for piano wire ...	...	4 6	1·5	...
Annealed piano wire ...	0·45	3·4	1 27	...
Silver wire	0·48	8 2	1 8	69·2
Copper wire	0·64	13·3	...	33 9
Copper wire	0·50	7 04	1·15	16 8

The results obtained show that neither magnetisation nor an electric current through a wire produces any appreciable effect upon the size of Young's modulus aside from that which can be attributed to the accompanying heat. All the wires show a permanent increase in elasticity produced by heating them, the increase being greatest for the silver and least for the copper wire.

The thermal coefficient of elasticity is somewhat smaller for annealed than for unannealed piano wire. The values found for the thermal coefficients of silver and copper wire are much larger than those that have been found by others who have worked upon this subject. (N. Katzenelsohn, *Beiblatter* xii., p. 307, 1888; H. Tomlinson, *Pro. Roy. Soc.*, xl., p. 343, 1886.) Perhaps the weights which her method of experiment made necessary were heavier than those used by other experimenters; the thermal coefficient may be quite different for weights nearly as large as the elastic limit from what it would be with smaller weights.

The temporary effects of heat upon the elastic limit of silver and copper wires are very marked. In some electric circuits for which copper wire is employed, it has been found that the wire stretches much more during the summer than it contracts when the cold weather returns. This is doubtless because the elastic limit is so decreased by the summer heat that the weight of the wire between the points of support stretched it beyond this limit. The fact that copper wires vary so much in the effect of heat upon the elastic limit, may need to be considered in selecting wires for telephone circuits or other purposes for which long wires are to be employed. This paper may therefore be commended specially to those of our readers who are interested in telephony.

CITY NOTES.

Pontypool Electric Light and Power Company.

Last year we drew attention to the eminently successful running of these works; the accounts for 1895 were in every respect as satisfactory, and we should not be very much surprised if some of the figures this year make a record. Pontypool, as an example of a small station worked economically, is deserving of considerable attention, and it seems to us that the methods of working which have been adopted there might with advantage be followed in many small towns where electricity is not yet in use. During last year a profit of £230 resulted, and of this £50 was carried to a reserve fund, and a dividend of 3 per cent. was paid on the capital. As we have already indicated, it is more than likely that better results will be achieved this year, judging by the working for the first seven months. It has to be remembered that the output at Pontypool is an exceedingly low one. Yet though the average number of units sold per month does not much exceed 2,000, the cost of coal per unit is ·34d. The following gives the output for the first seven months of 1896, with the coal cost per unit:—

	Units sold.	Cost of coal per unit.
January	4,604	·301
February	3,790	·313
March	2,723	·318
April	1,855	·336
May	1,491	·358
June	1,023	·387
July	1,115	·372
	Average	·34

The Edison Illuminating Companies.

The *Financial News* says that the Edison Electric Illuminating Company, of Brooklyn, reports gross earnings for July of $59,018, an increase of $9,918 as compared with the same month of last year, and net $24,138, an increase of $5,432. For the seven months ended July 31st, the gross earnings were $462,430, an increase of $161,608 as compared with the corresponding of last year, and net $205,274, an increase of $78,719.

The Edison Electric Illuminating Company of New York reports gross earnings for July of $156,891, an increase of $21,197 as compared with the same month of last year, and net $67,270, an increase of $8,736. For the seven months ended July 31st, the gross earnings were $1,262,795, an increase of $111,154 as compared with the corresponding period of last year, and net $611,803, an increase of $62,267.

Stock Exchange Notices.—The Stock Exchange Committee has appointed Tuesday, September 15th, a special settling day in Willans and Robinson, Limited—provisional certificates for £100,000 four-and-a-quarter per cent. first mortgage debenture stock, and ordered same to be quoted in the official list; also the City of London Electric Lighting Company, Limited. Further issue of £100,000 five per cent. debenture stock, in lieu of the provisional certificates now quoted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 6th, 1896, were £848; week ending September 8th, 1895, £839; increase, £9; total receipts for half-year 1896, £9,181; corresponding period, 1895, £8,508; increase, £673.

The Great Northern Telegraph Company. The traffic receipts in August, 1896, amounted to £24,400; 1st January to 31st August, 1896, £188,000; corresponding months, 1895, £202,800; corresponding months, 1894, £182,200.

The Liverpool Overhead Railway Company. The receipts for the week ending September 6th, 1896, amounted to £1,212; corresponding week last year £1,324; decrease, £112.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Sept. 2nd.	Closing Quotation, Sept. 9th.	Business done during week ended Sept. 9th, 1896. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	52 — 54	52 — 54	52⅜	52¼
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	97½ — 98½	97½ — 98½	98½	97⅜
2,993,560£	Do. do. Defd.	Stock	...	...	...	9 — 9⅛	9¼ — 9⅜	9⅜	9⅛
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	15½— 15⅝	15½ — 15⅝	15⅝	15⅜
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	4 %	3½— 4	3½ — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12¼ — 13¼xd	12¼ — 13½	12⅝	12½
5,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½xd	20½ — 21½	21	20½
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110 %	107 —110%	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	2¼%	9⅜— 10¼	9⅜ — 10¼	9⅝	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	6½%	18 — 18½	18 — 18½	18½	18¼
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	18½ — 19½	18½ — 19½	19½	19 7/16
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	104 —107	104 —107	106¼	106
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	131 —134	131 —134	133	132½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18 — 18½	18 — 18½	18⅜	18 3/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	130 —133	130 —133	131½	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	100 —104	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	...	...
800,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	107¾	106¼
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114 %	111 —114 %	112½	111¾
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% §	4½%	4½%	11¼— 11⅜	11¼ — 11⅜	11⅜	11⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	18 — 18½	18 — 18½	18⅜	18
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	24 — 25	24 — 25	25	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107xd	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 56	53 — 56	55¼	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112 xd	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5¼%	7½— 7⅝	7½ — 7⅝	7¾	7 9/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 18	17 — 18	18½	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅝— 7	6⅝ — 7⅛	6 13/16	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	107 —110	107 —110	109⅜	108¼
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	⅜— ⅞	⅜ — ⅞	13/16	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 — 111	109½	109
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 —145	144	141
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3¾— 4¼	3¾— 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 —106	101 —106	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	5 — 6	5 — 6	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 —105 xd	102 —105	103¼	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	99 — 104	99 —104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	8¾— 9½	8¾— 9½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7 — 7½	7 — 7½	...	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2¼— 2⅝	2¼— 2⅝	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	⅛%	⅞%	1⅛— 1⅜	1¼— 1½	1 5/16	1¼
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½— 12	11½ — 12	11 3/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —105 xd	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	9¼— 9⅜	9¼— 9⅜	9⅜	9¼
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7⅞— 8¼	7⅞— 8¼	8 3/16	8⅛
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	114 —117	114 —117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	16 — 17	16 — 17	17	16 11/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½— 18½	17½— 18½	18¼	18 3/16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	132 —136	132 —136	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	*nil*	8 — 9	8 — 9	...	...
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13⅜— 14¼	13⅜— 14¼	...	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	3½— 4½	5½— 6½	6¼	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13½— 13⅝	13 — 14	13⅜	13⅜
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —123	120 —123	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	11 — 12	12 — 13	12½	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	12 — 13	12 — 13	12⅝	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	11 — 12	11 — 12	11 11/16	11 3/16

* Subject to Founder's Shares.

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation Sept. 2nd.	Closing Quotation, Sept. 9th.	Business done during week ended Sept. 9th, 1896. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	S	5 %§	2½%	...	1½ — 1¾	1⅜ — 1⅝	1½	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %§	3 %	...	1¾ — 2	1¾ — 2	...	...
125,000†	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	110 —113xd	110 —113	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	97 —101	97 — 101	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	10⅛ — 10⅜	10⅛ — 10⅜	10⅜	10⅜
207,649	Do. do. do. £4 paid	10	...	...	...	4⅛ — 4⅜	4⅛ — 4⅜	4 5/16	...
630,000†	City and South London Railway	Stock	1¼%	1⅛%	1 1/16%	51 — 53	51 — 53	53	52
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %§	*nil*	*nil*	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1¾ — 2¼	1¾ — 2¼	2¼	2 1
17,139†	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	106¼	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1⅜ — 1⅝xd	1⅜ — 1⅝	1⅝	1½
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2¾ — 3¼xd	2¾ — 3¼	3⅛	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¾ — 1	¾ — 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝ — ⅝	⅝ — ⅝	...	...
9,600†	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10½ — 11½	10½ — 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	18 — 19xd	18 — 19	18⅛	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½xd	18½ — 19½	19	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	110 —115xd	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	22 — 23	21½ — 22½	22½	22 1/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	107 —110	107 —110	109½	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13½ — 13⅝	13½ — 13⅝xd	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅞ — 17⅛xd	16⅞ — 17⅛xd	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	40 — 43	40 — 43	42½	41½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000†	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8 — 8¼	8¼ — 8⅜	8½	8¼

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—5%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 6.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company (£5 paid), 4⅛—4⅜.
Do. do. 7 % Preference, of £5, 8¾—9¼.
Do. do. 4½% Debentures of £100, 109 - 111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10—10½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—8.

* From Birmingham Share List.

Bank rate of discount 2 per cent. (February 22nd, 1894).

ELECTRIC AND MAGNETIC RESEARCH AT LOW TEMPERATURES.

By Professor J. A. FLEMING, M.A., D.Sc., F.R.S., *M.R.I.*, Royal Institution of Great Britain—Weekly Evening Meeting, Friday, June 5th, 1896.

The Right Hon. Lord Kelvin, D.C.L., LL.D., F.R.S., Vice-President, in the chair.

(*Concluded from page* 317.)

We have in this way examined the behaviour of magnets made of a very large number of steels—chromium steels, aluminium steels, tungsten-steels, silicon-steels, and nickel-steels, in various states of temper, hard and soft. We find that in some cases there is no initial decrease of magnetism at all, and that the steady state begins at once. Broadly, however, the results amount to this:—A steel magnet, when plunged into liquid air, generally loses some fraction of its magnetisation, but that after a few such immersions it arrives at a fixed condition, in which the effect of cooling it is in most cases to produce an increase of magnetic moment, but in a few exceptional cases to produce a decrease of magnetic moment. In the case of the nickel-steels we have found very curious changes of magnetic moment as the magnet is heated up from − 186° C. to + 300°. There is a maximum magnetic moment at about 40° C. (see fig. 16) in the case of the 19 per cent. nickel-steel.

In the technical use of magnets for instrumental purposes, they have to go through a process called *ageing* to get rid of the sub-permanent magnetism. One of the best ways of ageing a magnet is to plunge it several times into liquid air.

We have given a large amount of attention to a study of the changes taking place in the magnetic qualities of soft or annealed, and also in hard iron when cooled to very low temperatures.

In the first place, we have examined the change in the permeability of iron at the temperature of liquid air. If a ring of iron is wound over with a coil of wire and subjected to gradually increasing magnetising forces, this force produces magnetisation in the iron, but the magnetisation does not increase proportionally with the force. It tends to a limit, and the curve which shows this variation is called a magnetisation curve. The number which expresses the ratio of the magnetisation to the magnetising force is called the susceptibility of the iron. Instead of considering the magnetisation of the iron as one of the variables, it is often convenient to consider the induction in the iron, and the induction is defined as a quantity, the rate of change of which, with time, measures the electromotive force set up in a secondary circuit wound round the iron ring.

The ratio between the induction and the magnetising force at any instant is called the permeability of the iron. By tedious experiments with the ballistic galvanometer, it is possible to draw out a complete magnetisation curve of the iron, starting from the lowest

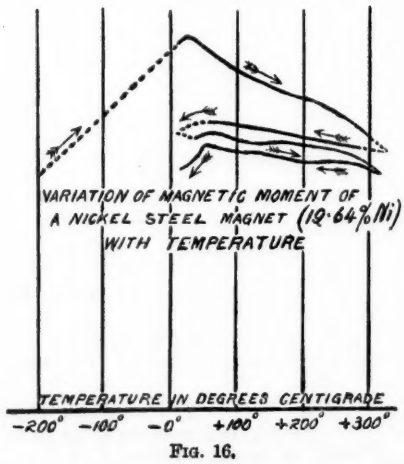

VARIATION OF MAGNETIC MOMENT OF
A NICKEL STEEL MAGNET (19·64% Ni)
WITH TEMPERATURE
TEMPERATURE IN DEGREES CENTIGRADE
-200° -100° -0° +100° +200° +300°

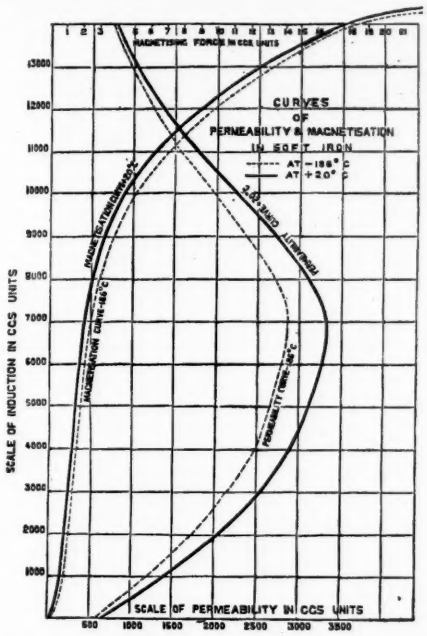
Fig. 16.

induction up to the point at which the iron becomes practically saturated. Assisted by Mr. J. E. Petavel, who has given us most valuable help in these very tedious magnetic observations, as well as in the subsequent reductions of them, a large number of observations have been made on the permeability of a carefully annealed iron ring made of very fine Swedish iron of the highest quality.* The result is to

* It is only right to add that in other portions of this work, especially in the resistance and thermo-electric work, we have been much indebted for careful and persevering assistance to Messrs. J. and D. Morris, and, in lesser degree, to Messrs. Jakeman and Tilney for help in other observations requiring several simultaneous observers.

show—as seen from the curve (see fig. 17)—that cooling the iron to — 186° C., slightly diminishes the permeability. In other words, it requires a greater magnetic force to produce a given amount of magnetisation when the iron is at — 186° C., than when it is at the ordinary temperature.

When, however, we began to study the behaviour of hardened iron in this respect, we found ourselves in the presence of very curious


MAGNETISING FORCE IN CGS UNITS
CURVES OF PERMEABILITY & MAGNETISATION IN SOFT IRON
AT — 186° C
AT + 20° C
MADE FLATTER BY STRETCHING
MAGNETISATION CURVE AT — 186° C
2.5% TWIST
PERMEABILITY CURVE AT — 186° C
SCALE OF INDUCTION IN CGS UNITS
SCALE OF PERMEABILITY IN CGS UNITS

Magnetisation and permeability curves of soft iron at 20° C. and — 186° C.

FIG. 17.

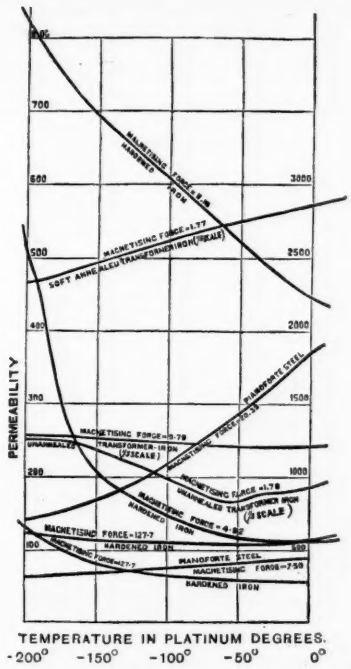
effects. If pure iron, which has been carefully annealed, is twisted, knocked, bent, stretched, or compressed, it passes into a state known as hard iron, and hard iron has very different magnetic qualities from soft iron. A very extended series of experiments with rings of hard iron have shown that hard iron, at least in certain cases, has its permeability greatly increased by cooling, and this change takes place with great suddenness. We can show you by a simple experiment that this is the case. If we take this hard iron ring, which has two coils of wire wound round it, and connect one of these circuits to a battery, we shall send a current through this primary coil and magnetise the iron ring. If the other, or secondary circuit is connected to a galvanometer, then at the instant of starting the primary current there is a transitory induced current produced in the secondary circuit. As long as the induction in the iron remains constant no electric change will take place in this secondary circuit. If, however, we plunge the iron ring into liquid air, whilst still keeping the primary current constant, we find again a secondary current produced at the moment of cooling the iron. This indicates a sudden increase of permeability at the instant of cooling. If we bring the ring out of the liquid air we find it retains some of the increased permeability acquired on cooling, but loses a portion of it more slowly if it is heated up again to ordinary temperatures by plunging it into a bath of alcohol. Owing to these changes we found it impossible to repeat again exactly any required magnetisation curve in the case of the hard iron. The sudden cooling alters the magnetic qualities of the unannealed iron to such an extent that it is not possible to get it twice in exactly the same state.

By subjecting a hard iron ring to frequent reversals of the same magnetising force, whilst it is warmed up slowly from the temperature of liquid air up to ordinary temperatures, we have been able to trace the gradual decrease of the permeability at any constant force throughout this range of temperature, and the results are embodied in the series of curves in fig. 18.

We have found, on the other hand, that unhardened steel pianoforte wire behaves like soft annealed iron.

We have then examined the hysteresis of iron at low temperatures. As the meaning of that term was very fully explained by the inventor of it in a discourse given quite recently, no time need be spent in an elaborate explanation of it. It is sufficient to say that when iron is magnetised and demagnetised, or carried round a cycle of magnetisation in which its direction of magnetisation is first in one direction and then in the other, this process involves the expenditure of energy, and such dissipation of energy is spoken of as the hysteresis loss in iron. It would occupy too much time to attempt to explain in full detail the manner in which this dissipated energy can be measured. As a matter of fact, the method we adopted was the laborious but exact one of delineating a complete magnetisation curve of the iron, by means of observations taken with the ballistic galvanometer for various maximum values of the magnetising force. In this way we were able finally to arrive at a curve which represented by its ordinates the value of the hysteresis loss in the iron in ergs per cubic centimetre per cycle, and the abscissæ the maximum value of the corresponding magnetic induction. When curves had been drawn out (see fig. 19) from all the many hundreds of observations for the case of the same soft iron ring at ordinary temperatures and at the temperature of liquid air, we found little or no sensible difference between them. The result is, then, that there is no appreciable change in the magnetic hysteresis loss of very carefully annealed soft Swedish iron when cooled to these low temperatures.* With regard to the hard iron, although the permeability is increased, it is most difficult to say yet whether the hysteresis is increased or not, as every fresh reduction in temperature of the iron alters its physical state, and makes it almost impossible to obtain similar repeated measurements.

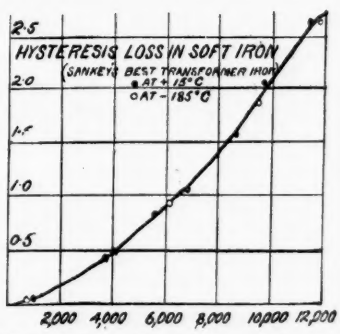
It is natural to inquire how far accepted theories of magnetic action are able to reconcile the above-mentioned results. Some of them undoubtedly are in accord with deductions from received hypo-



Curves showing the variation of permeability of iron with temperature between 0° C. and — 200° C.

FIG. 18.

thesis. It is generally considered that the facts connected with the magnetisation of iron indicate that each molecule, or perhaps small groups of molecules, of the iron are complete micro-magnets, and that in the unmagnetised condition of the iron, these molecular magnets arrange themselves in groups, or in closed circuits, so that for each little group the external magnetic action or magnetic moment is approximately zero. Magnetisation consists in arranging the



Variation of hysteresis loss in soft iron with temperature

FIG. 19.

members of some or all of these groups so as to co-lineate the direction of more or less of the molecular magnets, and produce an external resultant magnetic moment.

Let us then consider one such little group by the aid of a model made of small magnets, such as Ewing has suggested and used.

Suppose the members of this group to be at a certain distance from each other, and we apply a given magnetising force, which is just sufficient to open out the group, and co-lineate the magnetic axes of the several members of it.

Next, suppose we cool this iron, this would result in bringing the

* The iron used in all these experiments was a sample of Sankey's transformer iron, kindly sent to us by Mr. R. Jenkins.

members of the group into closer contiguity. The result of this will be an increase of the interpolar magnetic forces of the different members of the group; and as we can see from the behaviour of the model, it would require a greater magnetic force to effect the same amount of co-lineation of the molecular magnets. This, therefore, corresponds with what we find to be the case on cooling soft iron to very low temperatures. Prof. Dewar's experiments have shown that the tensile strength of iron and steel is increased to about double on cooling to − 182° C., and it is quite reasonable to suppose that this is the result, in part at least, due to an approximation of the molecules.

As regards the behaviour of magnetised steel and iron when cooled, it is highly likely, when the groups of molecular magnets have been opened out more or less, that some of these are in a condition of instability, in which bringing the members of the group nearer together will have the effect of making them close up again into magnetic circuits of no external action. Hence, if this is the case, the first effect of the sudden cooling will be to effect the observed change. These half-hearted groups of molecular magnets constitute the subpermanent magnetism which it is our desire to get rid of in ageing a magnet. Then, as regards the effect of temperature changes on the magnet when the stable condition of affairs is reached. In order to explain this, I think we must consider the action of the molecular groups upon each other. The approximation of molecular groups will in general, after the magnet is aged, have the effect of co-lineating more completely the different members of the groups, and hence increase the magnetic moment of the magnet, whilst the separation of the molecular groups, and the reverse effects ensue on heating. The action of the low temperature upon soft iron, and upon magnetised steel, would be explicable then, if we may legitimately make the assumption that lowering the temperature approximates the molecular groups, and also the members of each group.

The result of this, in the case of existing permanent magnetisation, is to close up more or less those groups which are in an unstable condition, but to increase the co-lineation in those groups in which the magnetic moment exceeds a certain value. Hence, in the case of the permanent magnet, the first effect of sudden cooling is a compound effect; it consists in a great reduction of the magnetic moment of certain unstable groups, but in an increase of moment of others. After this initial stage is past, the normal effect is an increase of magnetic moment of the groups, by bringing the members of them closer together, and a diminution by increase of distance. There remains then to be explained the anomalous behaviour of the nickel-steel and hardened iron; but an attempt to throw an inner light upon the results obtained with these substances, cannot possibly be successful until we have explored far more thoroughly, at low temperatures, the changes in mechanical as well as magnetic qualities.

Much as we may be tempted to speculate upon the causes of these various changes in the properties of matter at very low temperatures, a more important duty at the present time is the collection of facts and the completion of accurate quantitative measurements. The experimental difficulties of this low temperature research are very great, but both Prof. Dewar and I have been chiefly anxious in this particular work to prosecute preliminary explorations in as many regions of it as possible, these pioneering experiments enabling us to ascertain in what direction further inquiry will be profitable. Every step forward opens up fresh suggestions for investigation, and, I may add, fresh difficulties. In the light of the results, however, thus ascertained, we shall have additional means of testing and judging existing electrical theories, and the facts themselves, when built into the fabric of scientific knowledge, will serve to broaden those foundations on which we may profitably erect new hypotheses of electric and magnetic phenomena, which, if they can do but little to dissipate that mystery which enshrouds the most familiar facts, will serve as a continual stimulus to thought and work in days and years that are yet to come.

J. A. F.

CYRUS W. FIELD'S PERSONAL CHARACTERISTICS.*

In view of the interest that is being manifested at the present time in the proposition to commemorate the establishment of a comprehensive system of submarine telegraphy, the publication of the story of Cyrus W. Field's life by Mrs. Isabella Field Judson is peculiarly appropriate. George W. Smalley, who knew and admired Field, says the story is well told. In an elaborate review of this interesting work in the *New York Herald*, Mr. Smalley says: "The personal traits come out, and those are the most important. Anybody can string together dates and facts which are the skeleton of a human existence. Even that, though anybody can do it, is not an easy thing to do well. But to clothe the skeleton with flesh, to set the blood running in the veins, to reproduce the man as he was, to make him live again and move and talk—that is a very high form of literary art; so high that the number of really good biographies in the English language is not large, nor likely to be large. This is not to be ranked with the best, but it is an honest piece of work, and they who knew not Field may get from this, Mrs. Judson's life of him, a sufficient notion of the man and what he did." The story of that eventful life is graphically told:

"I never saw Cyrus so uneasy as when he was trying to keep still." So wrote one of his brothers in 1853. Cyrus Field was then 34 years old. He lived nearly 40 years longer, and to the end the saying was true. No man ever had a more restless energy. He seemed driven forward by an invisible and irresistible force. The force was himself. He was born so. When he died he had exhausted this apparently inexhaustible store of energy. But meantime he had changed the face of the world. It is difficult now to conceive of this terrestrial globe without submarine ocean cables. Yet it is but just 30 years since the first Atlantic cable was successfully laid and put in operation. It would have come in time, no doubt, without Field's help, but it was his work, and to him will belong for ever the imperishable renown springing from the accomplishment of one of those tremendous exploits which revolutionise the conditions of existence. He was then but 45 years old, and he had given 13 years of his life to the struggle.

The business side of him comes out early. "It is remembered of Cyrus Field as a child that his dealings with his playmates were most exact. He paid punctually all that he owed, and required the same punctuality in return." The habit was not peculiar to him. He was a New Englander, born in Stockbridge, Mass., where life had for generations been hard, and is, in some respects, still hard, and for the yeomanry of the old days—the farmers who lived on their farms—has become all but impossible. At 16 he thought himself old enough to seek his fortune.

"For three years before he had kept the family accounts, and had most carefully entered every item of expense in a small paper book, and he was well aware that it was only with strict economy that the $8 given to him by his father at parting could be spared from the family purse."

The early part of this book is full of details showing how pinched were his circumstances, and how methodical his expenditure. In an account sent to his father occurs one item which in these days seems remarkable enough. "To one steel pen, 12½ cents." I have grown used, during the last twelvemonth—the first year I have lived in America since 1867—to extortionate charges of many kinds. But no stationer has yet asked me to pay 12½ cents for a steel pen, nor should I know what to do with such a pen if I had it, nor with the still more stubborn stylograph.

Many of the details of this early life come from an autobiography of which toward the end of his life Field began the preparation. "Extracts are given without express credit," says Mrs. Judson. It was a mistake not to credit them. No biography is so interesting as an autobiography. What a man sets down about himself is certain to be truer, if it be true at all, than anything anybody can write about him. But there is, nevertheless, a great deal of Cyrus Field himself in this volume. It is interesting to think of the man who created the Atlantic cable as an errand boy in A. T. Stewart's store at $50 a year. Even he could not live on that sum, and he says: "My eldest brother lent me money, which, just as soon as I was able, and before I was 21, I returned to him with interest." This, too, is characteristic.

"I always made it a point to be at the store before the partners came, and never to leave before the partners left. Mr. Stewart was the leading dry goods merchant at that time. My ambition was to make myself a thoroughly good merchant. I tried to learn in every department all I possibly could, knowing I had to depend entirely on myself."

His letters as a boy are full of the spirit of thoroughness. His life was full of it. I saw a good deal of Field at various times, mostly in England, but also here in New York. I cannot conceive of him as doing anything without putting his whole soul into it. The most trivial action was an expression of energy. We drove together in a hansom one afternoon in London to make calls. The cabman did not know his way about very well, and Field was constantly signalling to him with his umbrella out of the front of the cab. The umbrella became a part of him as he pointed it hither and thither. He wielded this humble instrument as if it had been a marshal's bâton pointing the way to glory. The most obstinate cabman would not have dreamed of disobeying his peremptory gesture of command.

An anecdote by Jacob S. Schultz is new to me. Stewart, he once remarked, told him that he had taught Field all he ever knew about telegraphy. He said:—

"It is quite notorious in our house. Mr. Field was for a long time a clerk in that establishment, and Mr. Stewart said Mr. Field was in the habit of watching the old gentleman, and by a sort of tick-tick giving notice to his fellow clerks of the fact that he was coming, so that every man was in his place, and from that simple idea Mr. Field got the idea of telegraphing, which had made his fortune."

The anecdote would be more to the point if Field had been Morse. But it may be true enough. Field was not the man to throw away a hint of any kind.

I pass over all that part of Field's life between his boyhood and the actual laying of the cable. It is well known and well told in the biography. If I have dwelt a little on his boyhood, it is for the sake of the traits and incidents which indicate that the foundations of his after success were then laid. As usual, the child was father to the man. The Field whom I knew in London was already one of the foremost figures in the world. He ranked with Lesseps, and I can hardly think of a third. As I wrote the name I meant the Lesseps who, three years after the Atlantic cable was at work, summoned the world to see the meeting of the Mediterranean and the Red Sea, and the opening of a new pathway for the world's commerce. There is another likeness between them. Both lives ended in tragedies; the stamp of failure upon both at the end. It was a cruel stroke of fortune that brought each of these two great men low. In Field's case it was a grief to all Americans. Yet I imagine that history, though she may have to record the disaster of Panama, will take little note of the more personal misfortune which befel Cyrus Field. For myself, I can never think of him as other than the victorious adventurer, whose indomitable spirit bound the Old World and the New together.

For many years after Field had achieved this colossal work, his influence in promoting the union of England and America was felt in a different way. He was a kind of permanent ambassador to England, or, if not permanent, frequent. He had begun his mission, indeed, much earlier than that. Upon the assassination of President

* *Western Electrician.*

Lincoln, a meeting of Americans was held in London, at which Field said:

"Just before leaving America I called to see President Lincoln, and I know how deeply he desired peace in America, and peace in all the world. I trust, therefore, that everything calculated to stir up ill feeling between North and South—even the last sad deeds—or between England and America, will be allowed to die with the good man who has been taken away, and will be buried in his grave for ever. If Mr. Lincoln could speak to-day he would urge upon everyone to do all he could to allay the passions which have been excited in America, and I hope all will comply with what I believe would be his wish."

These pious hopes for a lasting friendship between Great Britain and the United States Field cherished to the last, and his efforts to ensure their fulfilment were continual. He was in a position to do much. He knew some of the best men in England, and had their confidence. The letters in this volume show it, but there was always evidence of it. Mr. Bright had an affection for him. Mr. Gladstone had—I will not say an affection, for I do not know whether affection be a part of his nature—but a regard for him, and a high sense of his usefulness, with a sort of sympathetic admiration for what Field had done. The two men resembled each other in at least one point—invincible energy of character. Each of them also had that supreme faith in himself, which is a condition of great achievement. The Duke of Argyle was another friend, and there were many more. Mr. Field saw all these men often enough to keep them informed about American opinion. Bright wrote to him in terms which showed how he valued his co-operation in his efforts for peace and goodwill.

During all that anxious period which preceded the Treaty of Washington and the Geneva arbitration, Field was in communication with leading men on both sides. He did much to bring about a meeting of minds. Bright, of course, needed no prompting, but Mr. Gladstone's feeling towards this country had never been over-cordial. The first great debate on the Alabama business, in which the House of Commons had shown itself, as a whole, really friendly to this country, was in 1868. Field telegraphed it to America. That is one example of what he could do. Some of the letters in this volume from Mr. Bright are of historical importance—one, for instance, in 1869, in which he discusses the Alabama difficulty with freedom and sense, saying to Field:—

"I write all this privately to you. It is not from a Cabinet Minister, but from an old friend of yours, who is a member of the English Parliament, and who has taken some interest in the affairs of your country."

Dean Stanley was another of Field's intimates, and though the excellent dean was not primarily concerned with international politics, he also proved ultimately a messenger of goodwill. Lord Ripon, one of the high commissioners of Washington, bore a curious testimony to the services of the cable itself in insuring the success of the negotiation.

"If it had not been for the existence of the cable, those negotiations must have been protracted in a manner which might have been very injurious to their success."

And Sir Stafford Northcote, afterward Lord Iddesleigh, said of the Atlantic cable:

"There can be no doubt that it was a main agent in the matter. We usually met our American colleagues at midday, and we were by that time in possession of the views of our home Government, as adopted by their Cabinet in the afternoon of the same day."

And Mr. Gladstone, at a dinner given by Mr. Field in London on Thanksgiving Day, in 1872, spoke of the union of the two countries as meaning, after all, the union of the men by whom they are inhabited, and then asked:

"Who is there, gentlemen, of them all that has been more marked, either by energetic motion or by happy success in that great undertaking—the accomplishment of the sacred work of union—than your chairman, who has gathered us around his hospitable board to-night?"

Mr. Gladstone spoke of Field again as one who, "often as he had crossed the ocean, had always been charged weightily upon every voyage with sentiments of kindness and goodwill, of which he has been the messenger between the one and the other people."

The relations between Mr. Field and these Englishmen were personal and often intimate. Perhaps I might say that the first time I met the Duke of Argyle and Mr. Gladstone was at a breakfast given by Mr. Field in the hotel at Buckingham Gate—a caravansary to which he clung with an undeviating pertinacity, I always thought, because he had begun there and disliked change. I have met Field also at one of the Thursday breakfasts in Downing Street, which it was Mr. Gladstone's habit to give. Mr. Bright readily went, as did the others, to these more public entertainments which the great American used to organise in connection with his telegraph business. When more money was to be raised for the laying of more cables there was always a dinner, and often on other occasions. But it was at the banquet given to Field at Willis's rooms, in London, that Mr. Bright pronounced his splendid eulogy on Mr. Field as the Columbus of the nineteenth century. That, at any rate, was the occasion on which the phrase was first heard in London. Mr. Bright said he had used it in a speech delivered in the north of England some time before. But, if my memory serves me, he had used it in a different form. The words now quoted are the final form and by far the best.

Of Field's American friendships and American career I need say nothing. There are others who know them far better than I do. He had his enemies here and also in England—what strong man has not enemies? He made mistakes. Mr. Phelps, at the dinner given him at the Mansion House, when he relinquished his post as American Minister, said, in a never-to-be-forgotten epigram, "A man who never makes a mistake never makes anything." Field's life ended in financial disaster. Two or three fortunes had passed through his hands; one, if not two, he had sacrificed sooner than sacrifice the gigantic undertaking he had resolved to carry through at no matter what cost. We are a people with whom wealth counts for so much—we make such a superstition of business success; we worship success so fervently—that this last ill fortune which befell Field has, perhaps, obscured in the eyes of the business world the real triumphs of his life and the real greatness of the man. They will not remain in obscurity. No eclipse of his fame can be permanent. It never was general. The world has done him full honour, whatever Wall Street may have withheld. His friends have remained his friends. They knew his true worth. It was not necessary to be blind to his faults in order to applaud his virtues. Let us take the man as a whole. The only true eulogy is that which takes account of all his qualities and all his defects. Thus judging him, and trying to weigh his life's work in the balance which after generations will use, I think we shall all reckon Field as one of the illustrious figures of his time.

NORTH-WESTERN ELECTRICAL ASSOCIATION.*

At the Convention of the North-Western Electrical Association, held at Marinette, Wis., July 15th, 16th, and 17th, another success was added to the record of this vigorous young organisation. While the attendance was not comparable to that of meetings of the several national electrical bodies, this was due rather to the necessarily limited membership, than to any lack of interest in the objects of the association, or in the proceedings of its sessions. The secretary reported a large number of new admissions, and indications point to still greater growth and prosperity.

Considerable discussion was held concerning the collection of data from central stations within the territory of the association, and an effort will be made during the coming year to obtain complete data relating to the cost of electric lighting in all central station towns in Wisconsin and contiguous territory in Michigan and Minnesota.

The movement to prevent hostile legislation will be continued, and it was shown that efforts in this line during the meeting of the Legislature in Wisconsin for the last couple of years have been crowned with much success, particularly in preventing legislation unfavourable to the establishment of municipal lighting plants at the expense of local plants.

The most prominent feature of the discussion was a very vigorous attack by Mr. John I. Beggs upon the National Electric Light Association, the main points of which are given below.

President Baker, in his address, referred to the desirability of continuing the efforts to obtain data concerning the cost of electric lighting from various central stations, in order that members may thereby be enabled to meet false statements designed to influence municipal bodies and the public. It was recommended that a close relationship should be established between electric light and insurance companies, as recently much hardship had been caused by the action of insurance inspectors in condemning wiring.

Secretary T. R. Mercein read a paper on the recent Convention of the National Electric Light Association and the National Electrical Exhibition, at which he represented his association in an official capacity. He referred to the feeling of antagonism between the National Electric Light Association and electrical manufacturers, which feeling, he stated, had not been thus far evident at any meeting of the North-Western Association. Mr. Mercein pronounced the papers presented at the New York Convention as both too technical and theoretical, and not calculated to meet the demand for general practical information. He also considered that the discussions were not spontaneous, and said he was struck by the aggressive manner of those asking information on the subject at hand, there seeming to be a desire to trip up the speaker, and many questions were apparently aimed at his discomfiture. In this respect he contrasted the uniformity of attention and courtesy accorded to speakers before the North-Western Electrical Association. He also referred to the marked contrast which he found between the free, spontaneous courtesy and hospitality of the West and the comparatively strained conventional manners of Eastern entertainers. Following are abstracts of the papers and discussions:—

Insurance of Electrical Plants.

Two papers were presented on this subject, one by Mr. C. C. Paige, and the other by Mr. R. H. Pierce. The former was a protest against the growing severity of electrical inspection, which, in some places, had caused the suspension of electrical service. In answer to the question: "Are the changes and improvements demanded by the insurance inspectors necessary to prevent fire and accident?" Mr. Paige feels that the answer will be "No," and his opinion is that underwriters' rules for wiring and installing apparatus for both public buildings and residences should be somewhat modified.

Mr. Pierce, in his paper, discusses more particularly the subject of the insurance of central stations, and after considering the several methods of insurance—by stock fire insurance companies, mutual companies and self insurance through securing the maximum safety through the use of proper construction—he pronounces in favour of the first named, stating that the plan of forming central station mutuals has been weighed in the balance and found wanting.

The third method mentioned, of securing maximum safety and then taking the chances, he considers may be the best in some, but only in very special cases. If the central station plant is so designed, installed and operated as to reduce the fire hazard to a minimum, the stock insurance companies will ask a minimum rate of insurance, which in most cases will be so small as to be no burden to the owner.

* *American Electrician.*

The added investment necessary to meet insurance requirements, he believes, will not only be profitable on account of lower insurance premiums, but also through involving a smaller chance of interruption to service, less repairs and smaller depreciation. The present rules, formulated by the Underwriters' National Electric Association, were spoken of as representing much thought, investigation, and experience. In conclusion, Mr. Pierce sums up by saying that the solution of the insurance problem is in intelligent construction and operation, and that the way to determine how to design, instal and operate plants and how to improve existing plans, is to carefully study and freely discuss the requirements of the Underwriters' National Electric Association as adopted by the various insurance bodies, and then apply the right principles and methods to the plants, both in design and operation.

In the discussion on the above papers, much complaint was made concerning the recent action of insurance inspectors in requiring old wiring to be made to conform to the latest rules. One of the speakers protested against the rule concerning "fishing wiring," and another declared that one State inspector did not know the ordinary distinctions and differences between wiring.

Mr. Cuno took a more favourable view of the situation, and said that the worst trouble was rather in the constant changes in the rules rather than in their severity. He thinks it is the safest way for every central station to do the work in strict conformity with insurance rules, and that a good job is a credit to both the electrical company and to the community, and obviates trouble.

Two-and-a-Half-Watt Lamps.

Mr. C. J. Buckley addressed the Convention on the subject of 2½-watt lamps, his argument being that it was simply a question whether a central station man should continue to use and burn low efficiency lamps, on which the manufacturers made a considerable profit, or whether the manufacturers would have to get themselves together and increase their investment, and make a lamp upon which central stations could make a profit. He believed that the lamp manufacturers should be required to make a lamp that will give customers a higher candle-power and better service; that will increase the capacity of stations to make money, and not, as at present, let the profits rest entirely with the lamp manufacturers.

Mr. Beggs stated that the Edison Companies had made a formal proposition to lamp manufacturers as follows:—Acceptance of lamps to be based upon a test of one lamp from each barrel, the test to run for 600 hours under an expert appointed by the several lighting companies; that for each 5 per cent. which the lamp falls below the standard, there shall be deducted 10 per cent. from the price of the lamp, and that if the lamp is 10 per cent. higher than specifications, 5 per cent. more shall be paid for it, which increase shall be continued until it reaches 100 per cent. more than the specifications require, when 50 per cent. more shall be paid. Every lamp shall be run until it drops to 12·2 C.P., when the life of that lamp shall be considered ended. Mr. Beggs believes that it is a very difficult thing to produce a good 2½-watt lamp, though some lamps of the type to which he had reference, had been made that burned for 1,000 hours. It was not known what caused this long life, it being a mere accident, but it showed that the elements were there, and the effort should now be to discover what these are.

National Electric Light Association.

Mr. John I. Beggs, in the discussion of the paper of Secretary T. R. Mercein, referred in very unfavourable terms to the present condition of the National Electric Light Association, which he declared simply exists at present to make a "fat position" for one man. He stated that he has challenged the National Electric Light Association to show a single thing it has ever done for the benefit of central stations, and the challenge still remains open. He condemned the lack of action concerning the encroachment of the manufacturing companies in lighting fields, stating that the committee appointed for that purpose had not convened since it was named, 15 months before the New York meeting. He did not know of a single thing done at the recent meeting of the National Electric Light Association which would interest any representative of a central station anywhere in the United States; that scarcely any resolutions passed by that association amounted to anything, because its membership is too meagre and unrepresentative; "they do not represent anything of importance, I say advisedly: they represent a few large companies in a few large cities, but the large companies in the large cities are in many instances controlled by the very people who are interested in exploiting apparatus." Mr. Beggs said he had attended four meetings of the National Association, had laboured in season and out of season trying to make it an active, aggressive body, labouring in the interest of electric lighting generally, but that all of his efforts had been without avail. The example of the North-Western Electric Association had led him to believe that local or sectional organisations were much more valuable than the National body under discussion. To illustrate the slackness of the methods of the officers of the Association, Mr. Beggs said that he had presented a resolution, which was unanimously and enthusiastically passed, to print at once a valuable paper which was presented at the New York Convention; and that while there was no reason why the paper should not have been distributed before the close of the Convention, yet he did not receive a copy of it until over two months after the close of the meeting, although the paper was only six or eight pages long.

The Rights of Electrical Companies.

In a paper with the above title, Mr. W. Clyde Jones, of the Chicago Bar, gave a *resumé* of the legal principles governing the use of the streets and highways for electrical purposes.

After discussing the case of the electric railway, it is stated that the question as to whether or not trolley poles and wires introduce a new servitude has been a hard fought battle, resulting in a decision in the affirmative in some of the States, and in a decision in the negative in other States. The most approved tendency, however, is toward the view that the electric street railway, with its auxiliaries of poles and wires, does not impose upon the street an additional burden for which the abutting property owner must be compensated.

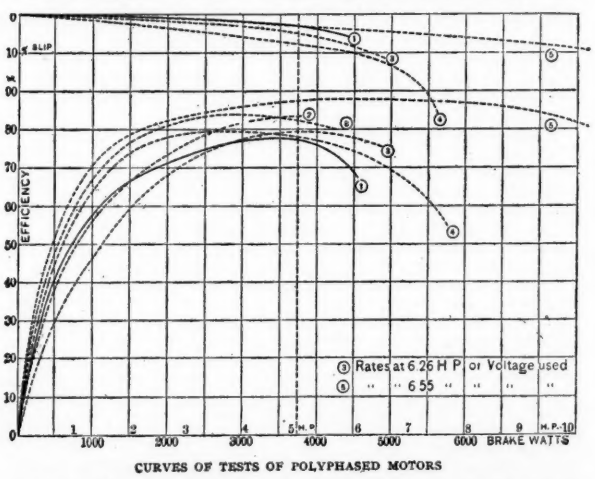
With respect to electric lighting wires and poles, since the same conductors are also employed for supplying current to street lamps, it was argued that this was a public necessity, and, therefore, a proper use of the street. Where the plant is owned by the municipality, the placing of the poles and wires in the street has been held to be a proper use, imposing no new burden. Where the plant is owned by private parties, though used for street lighting, some Courts have held the use of the streets to be a proper use, while others have held to the contrary. Where private plants have been used for private lighting only, there has also been a division of opinion. The tendency of decision, however, is toward the view that the use of the street for electric light wires is a proper use of the street, not imposing a new burden on the street such that abutting property owners must be compensated.

The telephone, since it calls the streets into service for its pole lines, has been attacked on the same grounds as the telegraph, since the telephone is but one form of telegraph. The argument may be made with more force, however, that the telephone assists in the use of the street for transportation purposes, since the many telephone conversations relieve the streets of the passage of the individuals who would otherwise have to meet in order to hold the conversations. The tendency of decision is, nevertheless, toward the view that the telephone, like the telegraph, imposes a new burden on the street, for which the property owner is entitled to compensation.

Concerning injury to underground piping from electrolysis produced by electric railway return currents, it is a well-established doctrine that everyone should so use his own as not to interfere with the rights of others, and it would, therefore, seem to be the duty of the electric railway companies to so operate their systems as not to interfere with mains laid in the street, and if the use of the ground circuit is essential, to devise some means to prevent deleterious action upon the pipes. A number of methods have been proposed which are claimed to prevent the destruction of the pipes, and if this be the fact, the question arises whether the Courts will not hold the electric railway companies responsible for damages done to the mains, when it is within their power to prevent such damage by the employment of available means.

Alternating Current Motors.

The most interesting paper, from the technical standpoint, read at the meeting was one by Prof. Dugald C. Jackson, giving an account of some comparative tests of alternating current motors made last



CURVES OF TESTS OF POLYPHASED MOTORS

winter by Messrs. J. H. Perkins and W. H. Williams in the laboratory of Wisconsin University. Five horse-power alternating current motors of the following makers were tested:—Fort Wayne Electric Corporation—two-phased; Stanley Electric Manufacturing Company—three-phased; Westinghouse Electric and Manufacturing Company—two-phased; General Electric Company—three-phased.

A 5 H.P. three-phased motor, made by the Allgemeine Electricitäts Gesellschaft, of Germany, was also included in the tests, and results of tests on machines made by the Oerlikon Works and by C. E. L. Brown, of Switzerland, were obtained. A 10-H.P. Westinghouse two-phased motor was also tested. A capacity of 5 H.P. in the motors to be tested was chosen, as that may be considered to be near the average capacity of motors used in the service of ordinary central stations. The results of the tests may therefore be accepted as representing, for the central stations, comparative results between the average motors which they may use on alternating current systems, and the results may also serve as a basis for comparison between average conditions of operating with continuous current and alternating current motors.

When Silvanus P. Thompson wrote his book on polyphase currents in 1895, he set forth as the requisites for a good alternating current motor that: 1. It shall exert a good torque at starting. 2. It shall be capable of running at a nearly constant speed at all loads. 3. It shall yield in mechanical power a high percentage of the power put into it—that is, it shall have a high commercial efficiency.

There are three additional requisites which Professor Thompson overlooked, but which determine to fully as great an extent the success of the motor. These are: *a*. The motor shall have a high power factor. *b*. It shall not require an abnormally large current

from the lines at the instant of starting. *c.* It shall not cause a large unbalancing of the pressures on the lines of a polyphase circuit.

The requisites, *a*, *b* and *c*, are so important that, if they are overlooked, a motor cannot give satisfaction to the central station man, however completely Prof. Thompson's requirements are fulfilled. The last two requisites are especially important where the motors are to be supplied directly from the lighting circuits.

In order to determine how far the alternating current motors in the market fulfil these essential requirements of a machine which will give satisfaction when operated on the circuits of a central station plant, Messrs. Perkins & Williams made tests of the following points:—

a. Starting torque and current. *b.* Speed regulation. *c.* Commercial efficiency at all loads. *d.* Power factor at all loads. *e.* Starting current. *f.* Effect on the line pressures when starting.

The measurements were made by the following methods:—

a. The power absorbed by the machine was measured by indicating wattmeters, the two-wattmeter method being usually employed.

b Currents and apparent watts were obtained from the readings of ammeters and voltmeters *in each circuit.*

c. Outputs were measured by a special self-adjusting Prony brake which proved to be entirely reliable.

d. Disturbance of the circuits upon starting the motors was determined by observing the action of incandescent lamps connected to independent transformers, and by voltmeter readings of the pressure on the lines.

e. The torque which the motor could exert when starting ("static torque" of the recapitulation) was measured by clamping the brake up tight and then balancing the pull of the motor. This is by no means the starting torque of the polyphase motors (that is, the torque corresponding to the load which the motor is capable of pulling up to speed), unless the armature starting resistance is subdivided. In only one of the polyphase motors tested was this the case, and all the others showed a starting torque below the maximum running torque. The results of the tests are clearly shown in the accompanying table and set of curves.

Recapitulation.—Comparative Quantities.

No.	Rated Capacity, H.P.	Rating of voltage used, H.P.	Torque, in per cent. of full load.			Starting current, in per cent. of full load.	Drop in speed at full load, per cent.	Efficiencies, per cent.					Power factors, per cent.					
			Max. running.	Static.	Start. ing.			Max. Eff.	¼ load.	½ load.	¾ load.	Full load.	Max. P. F.	0 load.	¼ load.	½ load.	¾ load.	Full load.
1	5	5	140	131	77	157	3·	77·8	55·2	70·6	77	76·6	76·4	13·	37·5	50·	62·3	71·5
2	5	5	100	45	44	153	...	83·8	54·5	72·5	80·5	83·8	67·5	10·5	25·5	58·	67·3	61·
3	5	6·26	104	90	83	114	9·7	79	52·	71·9	78·9	77·	81	74	81·6	83·3	83·7	84·
4	5	5	186·5	136	39·4	262	7·	79·5	62·2	77·2	79·5	77·8	82·6	15·5	44·7	62·5	73·7	80·3
5	5	6·55	171·	138·5	86·6	156	3·7	88	75·2	85·	87·7	88·	78·5	6·8	27·5	45·5	59·8	70·3
6	10	10	>147	142	137	194	4·5	82	67·	78·4	81·9	81·1	79·	15·	40·4	59·1	69	73·4
7	4·5	4·5	>163	232	...	357	3·7	79·1	61·	73·8	78·4	79·1	88·4	22·2	51·3	69·4	80·3	85·2
8	5	5	...	...	...	...	4·6	83·8	65·5	80·2	83·8	87·	89	...	52·	71·5	81·7	87·2

Note.—Nos. 6, 7 and 8 were not run up to maximum load, on test.

The best performance of the American 5 horse-power machines lies between No. 3 and No. 5 of the tables. These machines will stand well above the others. They are about even in starting torque, but No. 5 will carry considerably the higher load before dropping out of its pace; No. 5 also regulates the better and has the higher efficiency. On the other hand, No. 3 has a power factor incomparably better than any of the other machines. The question of efficiency and power factor affects the central station as follows:—

1. As power is (or at least always should be) sold by meter, the consumer pays for the losses of his motor, and it is of interest to the central station that the motors have a high efficiency only in order that a fair price per kilowatt hour delivered to the customer may not prove to convert into an excessive or even prohibitive per horse power hour, net, which is delivered by the motor to the customer's machinery.

2. On the other hand, the power factor strikes the central station directly; since a low power factor causes an increased current output, with an accompanying increased loss in the lines and transformers, and, even worse, with a demand for an excess capacity and therefore of cost in the generating machinery and transformers.

Supposing that the average load that may be assumed to be carried by a 5-H.P. motor is 3½-H.P., which is ordinary service; then the average efficiency and power factor of motor No. 3 are 75½ per cent. and 83½ per cent., and of motor No. 5 are 85 per cent. and 59 per cent. In other words, the central station must instal over 40 per cent. greater capacity in generators, lines and transformers to supply a given power service to motor No. 5 than would be necessary if motor No. 3 were used. This difference appears to wipe out the difference of 10 per cent. in efficiencies. In other words, the central station owner supplying power to motor No. 3 could probably afford, if necessary, to sell his power at enough lower price per kilowatt to make the customer's horse power of the same cost as if supplied by motor No. 5, and yet make more money and have better regulation on his plant.

The question of power distribution for alternating current stations, *as it now stands*, resolves itself into this:

1. If you have a 500-volt continuous current power service, stick to it.

2. If you can develop a large power service within a radius of 2 miles from the station, put in a 500-volt continuous current outfit.

3. If you can develop a small power service only, which cannot afford a duplication of apparatus, or your distances are excessive, then arrange to use alternating current motors.

4. In this case, arrange to operate all the lamps on one phase to avoid, as far as possible, difficulty in regulation, and instal such a generator and system of lines as will enable the use of motors.

5. Motors intended for such use should be guaranteed to have a high power factor and to start without taking an excessive current from the lines.

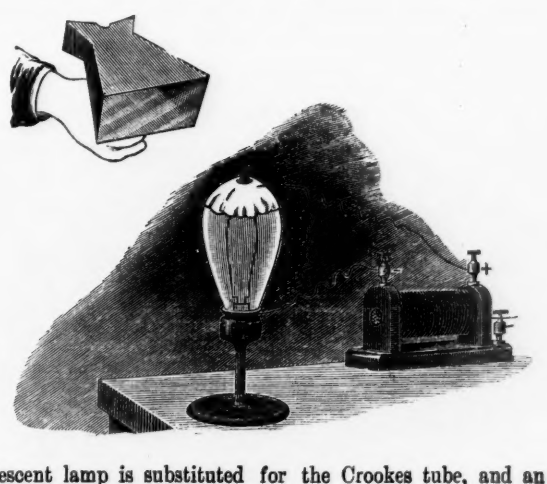
6. Never use recording ammeters with alternating current motors if you really intend to develop a power service, but use recording wattmeters to indicate the power absorbed by the motors.

7. Where two-phase or three-phase motors are used, place two recording wattmeters, properly connected, to indicate the total power by summing their readings. A single special meter, made up to serve the purpose of the two may be used, but such an instrument is not now on the market.

This summation is based on the assumption that uniformity of pressure at the lamps is valued by the central station man. Carelessness in regard to regulation is one of the features which has militated against the financial success of many alternating current stations, and its importance should be borne carefully in mind when considering the advisability of a combined light and power service. The lighting is generally the most important service to the station, and nothing should be done to injure its regularity and reliability.

INEXPENSIVE X RAY APPARATUS.

The expense of special Crookes tubes, powerful coils, and batteries has deterred many from entering this interesting field of experiment; but Mr. R. McNeil, of New York, has recently devised apparatus in which an ordinary incandescent lamp is substituted for the Crookes tube, and an induction coil of common form is made to supply electricity of sufficiently high potential to produce the X ray phenomena.



The lamp, says the *Scientific American*, which is a 52-volt, 16-candle-power Sawyer-Man lamp, is made of German or lime glass. For convenience, it is mounted in an insulating standard. The top of the lamp is covered with aluminum foil, which is connected with one terminal of the secondary of the induction coil, and the bottom is connected with the other terminal of the secondary, as shown. The X ray proceeds from the cathode. By means of the fluoroscope the shadows of the bones of the hands and feet, also of the limbs, may be seen, when they are placed between the instrument and the lamp.

It has been found in this experiment that when a blue fog appears in the lamp, the vacuum is too low for the best results. By placing the lamp in the house circuit for 15 or 30 minutes the high vacuum is restored by the heat and will remain good for about 15 minutes.

The coil is capable of giving a 3-inch spark, and the X ray produced by this simple and inexpensive apparatus is sufficient for making radiographs.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

18,666. "Improvements in means for the construction of submerged or partially submerged permanent ways for cars driven by electricity, steam, or other motive power; also for steep grade permanent ways for cable cars and the like." B. W. C. Botham. Dated August 24th.

18,669. "Improvements in means for suspending the electric conductors used in electric railways, tramways, and the like, known as the trolley wire." M. Volk. Dated August 24th.

18,680. "Fixed-contact apparatus for use with railway electric brakes." H. Georgin. Dated August 24th.

18,704. "Improvements in connection with electric traction systems." H. Allen and O. Peard. Dated August 24th.

18,711. "Appliance for preventing noise in wheel gearing of pumps, or any machine or machinery driven by electric or any other power." W. Wright. Dated August 24th.

18,730. "Improvements in or relating to alternate current motors." V. A. Fynn. Dated August 24th.

18,785. "Improvements in telephonic apparatus." C. J. Schwarze. Dated August 25th. (*Complete.*)

18,786. "An improved system of control for electric motors." H. H. Lake. (E. A. Sperry, United States.) Dated August 25th. (*Complete.*)

18,830. "Automatic electrical indication of the names of stations in each separate compartment of trains in motion." F. J. Longton. Dated August 25th.

18,839. "An electrical system of railroad and fog signalling, to be used in conjunction with the present system of railroad signalling." H. Gilhespie. Dated August 26th. (*Complete.*)

18,841. "The abolition of the commutator in continuous current dynamos and motors." S. A. Nash. Dated August 26th.

18,843. "Improvements in electrical switches." H. G. Richardson. Dated August 26th.

18,867. "Improved electric trolley mast." E. K. Scott. Dated August 26th.

18,878. "Improvements in gas valves actuated by means of electrical energy." The Midland Purchase Syndicate, Limited, W. H. Gritton, and W. Whittington. Dated August 26th.

18,889. "Improvements in electric light switches." A. P. Lundberg. Dated August 26th.

18,892. "Improvements relating to switch fuses or electric safety fuses." C. J. Hall and H. J. Fuller. Dated August 26th. (*Complete.*)

18,907. "An electric coin-freed apparatus for dispensing liquid refreshments." H. Imray. (O. Valdobra, Belgium.) Dated August 26th.

18,908. "An improved writing desk or slab, more particularly applicable as an adjunct to telephone receivers." F. C. Lehfeldt and J. Stevens. Dated August 26th. (*Complete.*)

18,912. "Improvements in or relating to telephone systems." M. Freudenberg. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 7th, 1896, being date of application in France.) Dated August 26th.

18,914. "An electrical means by which a hostile fleet or army may be rendered powerless." R. J. Crowley and W. O. Baker. Dated August 26th.

18,951. "Improvements in electrical accumulators." A. Conder and E. P. Michelot. Dated August 27th.

18,968. "Improvements in current actuated bell buoys." A. L Woodworth. Dated August 27th. (*Complete.*)

18,974. "A new or improved apparatus for electrically smelting metals, and for other like purposes." J. L. Dobell. Dated August 27th.

18,987. "Improvements in regulators for electric arc lamps." W. R. Lake. (A. Ferrario, Italy.) Dated August 27th.

19,021. "A new or improved incandescent electric lamp." J. Renous and B. Bronis-Lawski. Dated August 28th.

19,045. "Manufacture of secondary galvanic elements." A. Heil. Dated August 28th.

19,114. "Improvements in automatic switch devices for electric currents." J. T. Ashton. Dated August 29th.

19,148. "Improvements relating to electric current transformers." W. R. Lake. (The Elektrizitats-Aktiengesellschaft vormals Schuckert & Co., Germany.) Dated August 29th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps).*]

1895.

7,167. "Improvements relating to telegraphic working through cable lines." J. A. L. Deablove. Dated May 8th, 1895. Relates to an automatic punching instrument for punching the tape used for transmitting signals through a cable line. The punching instrument is constructed so that it is operated by feeble currents or electric impulses automatically transmitted through a second land or cable line. The new instrument practically makes a duplicate of the punched strip which is used to transmit the signals through the second line by means of the electric circuits forming the signals, the duplicate punched strip being used for re-transmitting the signals.

7,504. "Improvements in and relating to the distribution of alternating currents." G. Ferraris and R. Arno. Dated April 13th, 1895. Relates to a system for obtaining from a given alternating current, other alternating currents differing in phase, by means of a phase displacing transformer. One form of such a transformer is described, consisting of a two-phase rotatory field electric motor with a short circuited armature. Current is supplied from single-phase mains to one pair of coils and the armature is rotated; at the terminal of the second pair of coils a single-phase E.M.F. will be developed which is displaced in phase approximately one quarter period with regard to the main current. By these means a two-phase current can be obtained from single-phase mains. 6 claims.

10,539. "Improvements in dynamo-electric generators and motors." G. E. Dorman. Dated May 28th, 1895. Relates to various constructional improvements in the armatures and field magnets of dynamos and motors, these improvements referring firstly to the iron parts which are laminated, and secondly to the copper coils which are wound in a lathe or winding machine and then slipped on the cores. The main object is to cheapen the construction. 4 claims.

20,924. "Improvements in and connected with electrical annunciators. W. P. Thompson. (H. B. Higgins, of Minneapolis, U.S.A.) Dated November 5th, 1895. Relates to want, &c., indicators and call apparatus, and describes complicated constructional devices, the description of which cannot be abridged. 4 claims.

1896.

13,263. "A frictional grip for sliding rods, applicable to holders of electric lamps, carbons, and the like." W. L. Preece. Dated June 16th, 1896. Relates to a frictional grip which allows a sliding rod to be freely moved in one direction but holds it firmly when strained in the opposite direction unless it be released. When the rod or lamp head is tube-gripped it is passed through a sleeve which can slide within a socket being urged upward by a spring. In the sleeve are cut spaces receiving balls which are interposed between the rod and an internally coned part of the socket. When the rod is moved upwards it is free, but when pulled in the opposite direction, the balls tending to roll along the coned surface exert a wedging action on the rod, holding it firmly. By pushing the sleeve inwards and thereby moving the balls to a wider part of the cone the rod is left free, the spring tends to keep the sleeve and balls in the position to grip unless the sleeve be moved in opposition to the spring. 1 claim.

14,187. "A portable electric drill." E. Holmes and Siemens Bros. & Co., Ltd. Dated June 26th, 1896. Relates to a portable electric drill, the rotation of the drill spindle being effected by an electric motor mounted within the casing of the drill and connected by flexible conductors to a source of electricity. The motor, &c., is enclosed in a covered casing through which pass two handles screwed into the magnet, a workman, holding the whole by these handles, presses it down on the plate to be drilled. The shock is deadened when the drill has passed through by a caoutchouc ring held in a socket in the bottom of the casing. 1 claim.